Supplementary Appendix:
R&D Networks under Heterogeneous Firm Productivities

M. Sadra Heydari* Zafer Kanik† Santiago Montoya-Blandón‡

Contents

*Adam Smith Business School, University of Glasgow. Email: Sadra.HeydariMostafaabadi@glasgow.ac.uk
†Adam Smith Business School, University of Glasgow. Email: Zafer.Kanik@glasgow.ac.uk
‡Adam Smith Business School, University of Glasgow. Email: Santiago.Montoya-Blandon@glasgow.ac.uk

A Derivations

Throughout the provided derivations, we solve for a more general version of the model by introducing a new parameter that governs the efficacy of collaboration. That is, the marginal cost reduction equation becomes:

$$c_i\left(\mathbf{e}, \mathbf{G}\right) = \bar{c} - \theta_i\, e_i - \delta \sum_{j \in \mathcal{N}_i(\mathbf{G})} \theta_j\, e_j. \tag{1}$$

A.1 Quantity Competition with Heterogeneous Firms

We solve for the final stage of the game, in which the marginal cost of production is heterogeneous among the set of $\mathcal{N} = \{1, 2, \cdots, n\}$ competing firms. Each firm i decides how much to produce ($q_i(\mathbf{c})$), given the production cost of all firms $\mathbf{c} = \{c_j\}_{j \in \mathcal{N}}$. That is to solve:

$$\max_{q_i} \left\{ q_i \cdot [p(\mathbf{q}) - c_i] \right\} \quad \text{s.t.} \quad p(\mathbf{q}) = \alpha - Q,$$

where $Q = \sum_{j=\mathcal{N}} q_j$ is the total amount of supply [1], and α is a constant parameter characterising the size of the market. Each firm i maximizes its profit by selecting the best production amount q_i^* given the amount of production by others, i.e. $Q^{(-i)} = \sum_{j \neq i} q_j$, and its own production cost. Thus, firm i's profit is given by:

$$\begin{aligned}
\pi_i^{(m)} &= \max_{q_i} \left\{ q_i \cdot p(\mathbf{q}) - q_i \cdot c_i \right\} \\
&= \max_{q_i} \left\{ \alpha q_i - Q^{(-i)} q_i - q_i^2 - c_i\, q_i) \right\}.
\end{aligned}$$

Solving the first-order condition yields:

$$\left[\frac{\partial \pi_i^{(m)}}{\partial q_i} \right] : \quad \alpha - Q^{(-i)} - 2q_i^* - c_i = 0,$$

which results in a system of n equations and n unknowns, where each equation looks like:

$$2q_i^* + \sum_{j \neq i} q_j^* = \alpha - c_i.$$

Rearranging the equations into matrix form, we have:

$$\mathbf{B}_n q^* = h,$$

where $q^* = (q_i^*, \cdots, q_n^*)^\top$ is the vector of production quantities, $h = (\alpha - c_1, \cdots, \alpha - c_n)^\top$ is a vector related to the firms' production costs, and $\mathbf{B}_n$ is a constant $n \times n$ matrix which its diagonal elements are equal to 2 and all other elements are equal to 1, i.e.

$$\mathbf{B}_n = \mathbf{I}_n + \mathbf{1}_n\, \mathbf{1}_n^\top = \begin{pmatrix} 2 & 1 & \cdots & 1 \\ 1 & 2 & & \vdots \\ \vdots & & \ddots & \\ 1 & 1 & \cdots & 2 \end{pmatrix},$$

where $\mathbf{I}_n$ is an $n \times n$ identity matrix and $\mathbf{1}_n$ is an $n \times 1$ vector of ones.

Therefore, the equilibrium production amount could be determined using the following equation:

$$q^* = \mathbf{B}^{-1} h$$

Using the Sherman and Morrison (1950) formula, we know that the determinant of $\mathbf{B}_n$ is

$$|\mathbf{B}_n| = 1 + \mathbf{1}_n^\top\, \mathbf{I}_n^{-1}\, \mathbf{1}_n = n + 1,$$

indicating that $\mathbf{B}_n$ is invertible, and the inverse is:

$$\mathbf{B}_n^{-1} = \mathbf{I}_n^{-1} - \frac{\mathbf{I}_n^{-1}\, \mathbf{1}_n\, \mathbf{1}_n^\top\, \mathbf{I}_n^{-1}}{1 + \mathbf{1}_n^\top\, \mathbf{I}_n^{-1}\, \mathbf{1}_n} = \mathbf{I}_n - \frac{1}{n+1} \mathbf{1}_n\, \mathbf{1}_n^\top = \frac{1}{n+1} \begin{pmatrix} n & -1 & \cdots & -1 \\ -1 & n & & \vdots \\ \vdots & & \ddots & \\ -1 & -1 & \cdots & n \end{pmatrix},$$

[1] Here we assume that the amount of production (q_i) is continuous.

which is an $n \times n$ matrix with diagonal elements equal to $\frac{n}{n+1}$ and non-diagonal elements equal to $\frac{-1}{n+1}$. Thus, the equilibrium production amount for each firm i is

$$\begin{aligned} q_i^* &= \frac{1}{n+1}\left(n\,(\alpha - c_i) - \sum_{j\neq i}(\alpha - c_j)\right) \\ &= \frac{1}{n+1}\left(\alpha - n\,c_i + \sum_{j\neq i} c_j\right) \\ &= \frac{1}{n+1}\left(\alpha - c_i + \sum_{j=1}^{n}(c_j - c_i)\right). \end{aligned} \tag{2}$$

Moreover, the total amount of production in the equilibrium is

$$Q^* = \sum_{i=1}^{n} q_i^* = \frac{1}{n+1}\sum_{i=1}^{n}(\alpha - c_i),$$

and the equilibrium price is[2]

$$p^*(\mathbf{c}) = \alpha - Q^* = \frac{\alpha}{n+1} + \frac{\sum_{i=1}^{n} c_i}{n+1} = \frac{1}{n+1}\,\alpha + \frac{n}{n+1}\,\left(\frac{1}{n}\sum_{i=1}^{n} c_i\right). \tag{3}$$

Using equation (1), we can rewrite equation (2) as:

$$\begin{aligned} q_i^* &= \frac{1}{n+1}\left[\alpha - n\left(\bar{c} - \theta_i e_i - \delta\sum_{j=1}^{n}\theta_j\,e_j\,\mathbf{G}_{ij}\right) + \sum_{j\neq i}\left(\bar{c} - \theta_j e_j - \delta\sum_{k=1}^{n}\theta_k\,e_k\,\mathbf{G}_{kj}\right)\right] \\ &= \frac{1}{n+1}\left[(\alpha - \bar{c}) + (n+1)\,\theta_i e_i + (n+1)\,\delta\sum_{j\in\mathcal{N}_i(\mathbf{G})}\theta_j e_j - \sum_{k=1}^{n}\theta_k e_k - \delta\sum_{k=1}^{n}\theta_k e_k\sum_{j=1}^{n}\mathbf{G}_{kj}\right] \\ &= \frac{1}{n+1}\left[(\alpha - \bar{c}) + (n+1)\,\theta_i e_i + (n+1)\,\delta\sum_{j\in\mathcal{N}_i(\mathbf{G})}\theta_j e_j - \sum_{k=1}^{n}\theta_k e_k - \delta\sum_{k=1}^{n}\theta_k e_k\,d_k(\mathbf{G})\right] \end{aligned}$$

Therefore:

$$q_i^* = \frac{1}{n+1}\left((\alpha - \bar{c}) + (n+1)\,\theta_i e_i + (n+1)\,\delta\sum_{j\in\mathcal{N}_i(\mathbf{G})}\theta_j e_j - \sum_{k=1}^{n}\theta_k e_k(1 + \delta\,d_k(\mathbf{G}))\right)$$

$$= \underbrace{\frac{\alpha - \bar{c}}{n+1}}_{\text{baseline output}} + \underbrace{\frac{n - \delta\,d_i(\mathbf{G})}{n+1}\,\theta_i e_i}_{\text{own effort effect}} + \underbrace{\delta\sum_{j\in\mathcal{N}_i(\mathbf{G})}\theta_j e_j}_{\text{neighbor benefit}} - \underbrace{\frac{1}{n+1}\sum_{k\neq i}(1 + \delta\,d_k(\mathbf{G}))\,\theta_k e_k}_{\text{general competition effect}} \tag{4}$$

$$= \underbrace{\frac{\alpha - \bar{c}}{n+1}}_{\text{baseline}} + \underbrace{\frac{n - \delta\,d_i(\mathbf{G})}{n+1}\,\theta_i e_i}_{\text{own effort effect}} + \underbrace{\sum_{j\in\mathcal{N}_i(\mathbf{G})}\frac{\delta\,(n+1-d_j(\mathbf{G})) - 1}{n+1}\,\theta_j e_j}_{\text{neighbors' effort effect}} - \underbrace{\sum_{k\in\mathcal{N}_{-i}(\mathbf{G})}\frac{1+\delta\,d_k(\mathbf{G})}{n+1}\,\theta_k e_k}_{\text{non-neighbors' effort effect}}, \tag{5}$$

where $\mathcal{N}_{-i}(\mathbf{G}) = \{j \in \mathcal{N} \mid \mathbf{G}_{ij} = 0\,, j \neq i\}$ is the set of firm i's non-neighbors in network $\mathbf{G}$.

Finally, firm i's profit is:

$$\begin{aligned} \pi_i^{(m)} = q_i^*\,(p^* - c_i) &= \frac{1}{n+1}\left(\alpha - c_i + \sum_{j=1}^{n}(c_j - c_i)\right)\,\left(\frac{\alpha + \sum_{j=1}^{n} c_j}{n+1} - c_i\right) \\ &= \frac{1}{(n+1)^2}\left(\alpha - c_i + \sum_{j=1}^{n}(c_j - c_i)\right)^2 = {q_i^*}^2. \end{aligned} \tag{6}$$

[2]There is a possibility that a firm will have higher marginal production costs than the equilibrium prices, which consequently results in a corner solution to the firm's maximization problem. We assume this case does not happen in this study.

A.2 Optimal Effort

Given the solution of the final stage, we solve for the optimal R$D effort ($e_i$) in firms' profit maximization problem. That is:

$$\pi_i = \max_{e_i} \left\{ \pi_i^{(m)} - \phi\ e_i^2 \right\} \quad \text{s.t.} \quad \text{Equation (6)}.$$

Using equations (2) and (6) we get the following first-order condition:

$$\left[\frac{\partial \pi_i}{\partial e_i}\right] : \qquad \left.\frac{\partial \pi_i^{(m)}}{\partial e_i}\right|_{e_i^*} - 2\ \phi\ e_i^* = 0,$$

where $e_i^* = \arg\max_{e_i}\{\pi_i^{(m)} - \phi\ e_i^2\}$, and the partial derivative of market profit with respect to the R&D effort is given by:

$$\frac{\partial \pi_i^{(m)}}{\partial e_i} = 2\ q_i^*\ \frac{\partial}{\partial e_i}\left(\frac{1}{n+1}\left[\alpha - n\ c_i + \sum_{j\neq i} c_j\right]\right) = \frac{2\ q_i^*}{n+1}\ \left(-n\ \frac{\partial c_i}{\partial e_i} + \sum_{j\neq i}\frac{\partial c_j}{\partial e_i}\right).$$

Using the equation for marginal production cost((**??**), we have the following:

$$\left.\begin{array}{l} \partial c_i/\partial e_i = -\theta_i \\ \partial c_j/\partial e_i = -\delta\ \theta_i\ \mathbf{G}_{ij} \end{array}\right\} \implies \frac{\partial \pi_i}{\partial e_i} = \frac{2\ q_i^*}{n+1}\ \theta_i\ \left(n\ -\delta \sum_{j\neq i}\mathbf{G}_{ij}\right) - 2\ \phi\ e_i.$$

Therefore, the first-order condition can be reformulated as:

$$\left[\frac{\partial \pi_i}{\partial e_i}\right] : \qquad \frac{2\ q_i^*}{n+1}\ \theta_i\ \left(n\ -\delta\ d_i(\mathbf{G})\right) - 2\ \phi\ e_i^* = 0, \tag{7}$$

where q_i denotes the equilibrium production amount in equation (2), and $d_i(\mathbf{G}) = |\mathcal{N}_i(\mathbf{G})| = \sum_{j\in\mathcal{N}}\mathbf{G}_{ij}$ is firm i's degree in the network $\mathbf{G}$.

Replacing equation (4) into (7), we have:

$$\phi\ e_i^* = \frac{n-\delta\ d_i(\mathbf{G})}{n+1}\ \theta_i \left(\frac{\alpha-\bar{c}}{n+1} + \frac{n-\delta\ d_i(\mathbf{G})}{n+1}\ \theta_i e_i^* + \delta \sum_{j\in\mathcal{N}_i(\mathbf{G})}\theta_j e_j - \frac{1}{n+1}\sum_{k\neq i}(1+\delta\ d_k(\mathbf{G}))\ \theta_k e_k\right).$$

By defining $eta_i(\mathbf{G}) := \frac{n-\delta\ d_i(\mathbf{G})}{n+1}$, the first-order condition becomes:

$$e_i^* = \underbrace{\frac{1}{\frac{\phi}{\theta_i\ \eta_i(\mathbf{G})} - \theta_i\ \eta_i(\mathbf{G})}}_{\text{connectivity}} \left(\underbrace{\frac{\alpha-\bar{c}}{n+1}}_{\text{baseline}} + \underbrace{\delta \sum_{j\in\mathcal{N}_i(\mathbf{G})}\theta_j e_j}_{\text{collaboration benefit}} \underbrace{- \frac{1}{n+1}\sum_{k\neq i}(1+\delta\ d_k(\mathbf{G}))\ \theta_k e_k}_{\text{competition effect}}\right) \tag{8}$$

$$= \underbrace{\frac{\theta_i\ \eta_i(\mathbf{G})}{\phi - \theta_i^2\ \eta_(\mathbf{G})}}_{\text{connectivity}} \left(\underbrace{\frac{\alpha-\bar{c}}{n+1}}_{\text{baseline}} + \underbrace{\sum_{j\in\mathcal{N}_i(\mathbf{G})}\frac{\delta\ (n-d_j(\mathbf{G})+1)-1}{n+1}\ \theta_j e_j}_{\text{neighbor effect}} - \underbrace{\sum_{k\in\mathcal{N}_{-i}(\mathbf{G})}\frac{1+\delta\ d_k(\mathbf{G})}{n+1}\ \theta_k e_k}_{\text{non-neighbor effect}}\right). \tag{9}$$

Equation (9) denotes the best response function of each firm i (e_i^*) given the action of other firms (e_j) given the structure of the collaboration network, which results in a system of n equations and n unknowns. That is:

$$\left[\frac{1}{\theta_i}\frac{(n+1)^2\phi}{(n-\delta\ d_i(\mathbf{G}))} - (n+1)\ \theta_i\right] e_i^* = (\alpha-\bar{c}) + \sum_{j=1}^{n}\theta_j e_j^*\ \left[(n+1)\ \delta\ \mathbf{G}_{ij} - (1+\delta\ d_j(\mathbf{G}))\right]. \tag{10}$$

A.3 Deviation from a Complete network

Without the loss of generality, we consider a network $\mathbf{G} := \mathbf{G}^C_{-1,2}$, in which all firms are connected to each other except for firms 1 and 2.

Rewriting the initial system of equations, we have:

$$\left[\frac{(n+1)^2\phi}{2\theta_1} - 2\theta_1\right] e_1 = (\alpha - \bar{c}) + \sum_{j=3}^{n} \theta_j e_j - (n-1)\theta_2 e_2 \tag{11}$$

$$\left[\frac{(n+1)^2\phi}{2\theta_2} - 2\theta_2\right] e_2 = (\alpha - \bar{c}) + \sum_{j=3}^{n} \theta_j e_j - (n-1)\theta_1 e_1 \tag{12}$$

For $i \geq 3$, the equation is:

$$\frac{(n+1)^2\phi}{\theta_i} e_i = (\alpha - \bar{c}) + \sum_{j=3}^{n} \theta_j e_j + 2\theta_1 e_1 + 2\theta_2 e_2 \tag{13}$$

We define the coefficients b_i as follows:

$$\begin{aligned} b_1 &= \frac{(n+1)^2\phi}{2\theta_1} - 2\theta_1 \\ b_2 &= \frac{(n+1)^2\phi}{2\theta_2} - 2\theta_2 \\ b_i &= \frac{(n+1)^2\phi}{\theta_i} \quad \text{for } i \geq 3 \end{aligned}$$

Substituting these definitions into the system:

$$\begin{cases} b_1 e_1 + (n-1)\theta_2 e_2 = (\alpha - \bar{c}) + \sum_{j=3}^{n} \theta_j e_j \\ b_2 e_2 + (n-1)\theta_1 e_1 = (\alpha - \bar{c}) + \sum_{j=3}^{n} \theta_j e_j \end{cases} \tag{14}$$

Since the right-hand sides are identical, we equate the left-hand sides:

$$\begin{aligned} b_1 e_1 + (n-1)\theta_2 e_2 &= b_2 e_2 + (n-1)\theta_1 e_1 \\ [b_1 - (n-1)\theta_1] e_1 &= [b_2 - (n-1)\theta_2] e_2 \\ e_1 &= \frac{b_2 - (n-1)\theta_2}{b_1 - (n-1)\theta_1} e_2 \end{aligned}$$

Substituting the expressions for b_1 and b_2 back into the ratio:

$$e_1 = \frac{\theta_1}{\theta_2} \frac{(n+1)\phi - 2\theta_2^2}{(n+1)\phi - 2\theta_1^2} e_2 \tag{15}$$

We define λ to represent this ratio:

$$\lambda = \frac{\theta_1}{\theta_2} \frac{(n+1)\phi - 2\theta_2^2}{(n+1)\phi - 2\theta_1^2} \implies e_1 = \lambda e_2 \tag{16}$$

Define T as the sum over the remaining terms:

$$T = \sum_{j=3}^{n} \theta_j e_j \tag{17}$$

From the first equation of the system:

$$\begin{aligned} b_1 e_1 + (n-1)\theta_2 e_2 &= (\alpha - \bar{c}) + T \\ b_1(\lambda e_2) + (n-1)\theta_2 e_2 &= (\alpha - \bar{c}) + T \\ e_2[b_1\lambda + (n-1)\theta_2] &= (\alpha - \bar{c}) + T \end{aligned} \tag{18}$$

Define S to include the first two terms:

$$S = T + 2\theta_1 e_1 + 2\theta_2 e_2 \tag{19}$$

For $i \geq 3$, the equation becomes:

$$b_i e_i = (\alpha - \bar{c}) + S \implies e_i = \frac{(\alpha - \bar{c}) + S}{b_i} \tag{20}$$

now, substitute e_i back into the definition of T:

$$T = \sum_{j=3}^{n} \theta_j e_j = \sum_{j=3}^{n} \frac{\theta_j}{b_j}[(\alpha - \bar{c}) + S]$$

$$T = \left(\sum_{j=3}^{n} \frac{\theta_j}{b_j} \right) ((\alpha - \bar{c}) + S)$$

Define

$$Q \coloneqq \sum_{j=3}^{n} \frac{\theta_j}{b_j} = \sum_{j=3}^{n} \frac{\theta_j^2}{(n+1)^2 \phi} = \frac{\sum_{j=3}^{n} \theta_j^2}{(n+1)^2 \, \phi}.$$

Then:

$$T = Q(\alpha - \bar{c}) + QS \tag{21}$$

Substitute T back into the expression for S:

$$S = [Q(\alpha - \bar{c}) + QS] + 2\theta_1 e_1 + 2\theta_2 e_2$$
$$S(1 - Q) = Q(\alpha - \bar{c}) + 2\theta_1 e_1 + 2\theta_2 e_2$$
$$S = \frac{Q}{1 - Q}(\alpha - \bar{c}) + \frac{2\theta_1 e_1 + 2\theta_2 e_2}{1 - Q}$$

Recall $e_1 = \lambda e_2$. Substituting this into S:

$$S = \frac{Q}{1 - Q}(\alpha - \bar{c}) + \frac{2(\lambda\theta_1 + \theta_2)e_2}{1 - Q} \tag{22}$$

From equation (18), we use the consistent sign convention:

$$e_2 = \frac{(\alpha - \bar{c}) + T}{b_1\lambda + (n-1)\theta_2} = \frac{(\alpha - \bar{c})(1 + Q) + QS}{b_1\lambda + (n-1)\theta_2} \tag{23}$$

Substituting e_2 into the S equation:

$$S = \frac{Q}{1 - Q}(\alpha - \bar{c}) + \frac{2(\lambda\theta_1 + \theta_2)}{1 - Q} \left[\frac{(\alpha - \bar{c})(1 + Q) + QS}{b_1\lambda + (n-1)\theta_2} \right] \tag{24}$$

Define Δ:

$$\Delta = \frac{2(\lambda\theta_1 + \theta_2)}{b_1\lambda + (n-1)\theta_2} \tag{25}$$

The equation for S becomes:

$$S = \frac{Q}{1 - Q}(\alpha - \bar{c}) + \frac{\Delta}{1 - Q}[(\alpha - \bar{c})(1 + Q) + QS]$$
$$S \left(1 - \frac{\Delta Q}{1 - Q} \right) = (\alpha - \bar{c}) \left[\frac{Q}{1 - Q} + \frac{\Delta(1 + Q)}{1 - Q} \right]$$

Simplifying the terms:

$$1 - \frac{\Delta Q}{1 - Q} = \frac{1 - Q - \Delta Q}{1 - Q} = \frac{1 - (1 + \Delta)Q}{1 - Q}$$
$$\frac{Q + \Delta(1 + Q)}{1 - Q} = \frac{Q + \Delta + \Delta Q}{1 - Q} = \frac{\Delta + (1 + \Delta)Q}{1 - Q}$$

Thus:

$$S \left(\frac{1 - (1 + \Delta)Q}{1 - Q} \right) = (\alpha - \bar{c}) \left(\frac{\Delta + (1 + \Delta)Q}{1 - Q} \right) \tag{26}$$

Solving for S:

$$S = (\alpha - \bar{c}) \frac{\Delta + (1 + \Delta)Q}{1 - (1 + \Delta)Q} \tag{27}$$

Substitute the derived S back into the expression for T:

$$\begin{aligned} T &= Q(\alpha - \bar{c}) + QS \\ &= Q(\alpha - \bar{c}) \left[1 + \frac{\Delta + (1+\Delta)Q}{1 - (1+\Delta)Q} \right] \\ &= Q(\alpha - \bar{c}) \left[\frac{1 - (1+\Delta)Q + \Delta + (1+\Delta)Q}{1 - (1+\Delta)Q} \right] \\ &= Q(\alpha - \bar{c}) \left[\frac{1+\Delta}{1 - (1+\Delta)Q} \right] \end{aligned}$$

$$\boxed{T = (\alpha - \bar{c}) \frac{Q(1+\Delta)}{1 - (1+\Delta)Q}} \tag{28}$$

Solution for e_2

We substitute the value of T into the expression for e_2:

$$\begin{aligned} e_2 &= \frac{(\alpha - \bar{c}) + T}{b_1\lambda + (n-1)\theta_2} \\ &= \frac{1}{b_1\lambda + (n-1)\theta_2} \left[(\alpha - \bar{c}) + (\alpha - \bar{c}) \frac{Q(1+\Delta)}{1 - (1+\Delta)Q} \right] \\ &= \frac{\alpha - \bar{c}}{b_1\lambda + (n-1)\theta_2} \left[1 + \frac{Q(1+\Delta)}{1 - (1+\Delta)Q} \right] \\ &= \frac{\alpha - \bar{c}}{b_1\lambda + (n-1)\theta_2} \left[\frac{1 - (1+\Delta)Q + Q(1+\Delta)}{1 - (1+\Delta)Q} \right] \\ &= \frac{\alpha - \bar{c}}{b_1\lambda + (n-1)\theta_2} \left[\frac{1}{1 - (1+\Delta)Q} \right] \end{aligned}$$

Thus, the final expression is:

$$\boxed{e_2 = \frac{\alpha - \bar{c}}{b_1\lambda + (n-1)\theta_2} \left(\frac{1}{1 - (1+\Delta)Q} \right)} \tag{29}$$

Solution for e_1

Substituting the closed-form equation for e_2 into $e_1 = \lambda\, e_2$ we get:

$$\boxed{e_1 = \frac{\alpha - \bar{c}}{b_1\lambda + (n-1)\theta_2} \left(\frac{\lambda}{1 - (1+\Delta)Q} \right)} \tag{30}$$

Solution for e_i $(i \geq 3)$

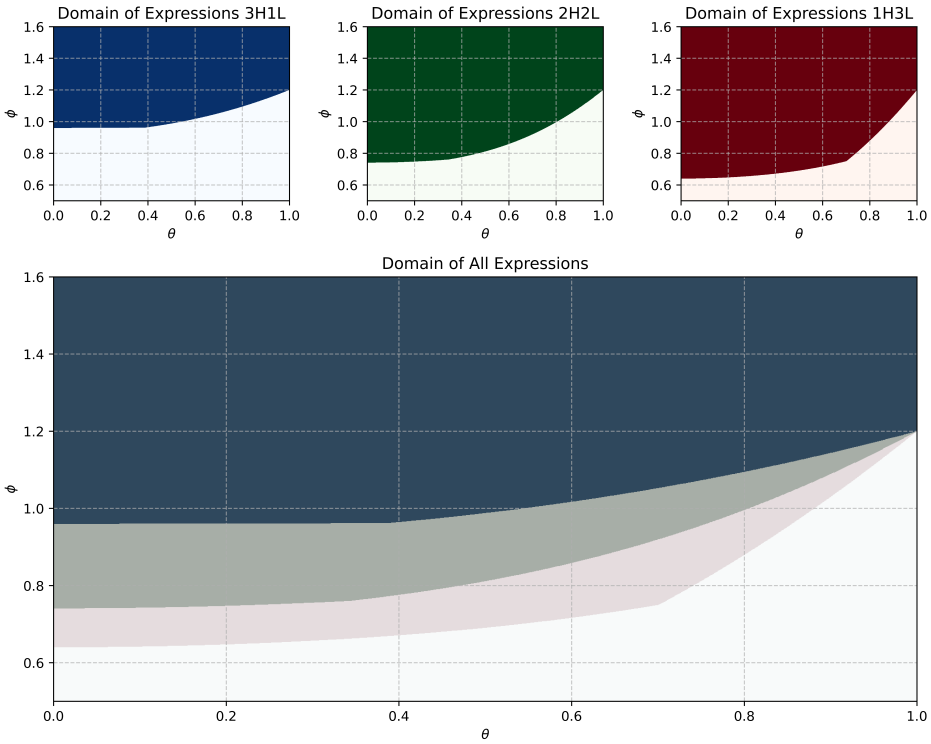
$$\begin{aligned} e_i &= \frac{1}{b_i}[(\alpha - \bar{c}) + S] \\ &= \frac{\alpha - \bar{c}}{b_i} \left[1 + \frac{\Delta + (1+\Delta)Q}{1 - (1+\Delta)Q} \right] \\ &= \frac{\alpha - \bar{c}}{b_i} \left[\frac{1 - (1+\Delta)Q + \Delta + (1+\Delta)Q}{1 - (1+\Delta)Q} \right] \end{aligned}$$

$$\boxed{e_i = \frac{\alpha - \bar{c}}{b_i} \left(\frac{1+\Delta}{1 - (1+\Delta)Q} \right)} \tag{31}$$

B Stability Domain

For the system of equations in all of the cases studied in the following sections, the value of the cost controlling parameter ϕ should be high enough to guarantee that the result of the effort optimizations are positive. In order to achieve this, the numerator of all the optimal efforts in Section D should be positive. Figure 1 depicts the domain in which the said conditions hold for different configurations of the market. This figure suggests the value of the cost parameter ϕ should be larger than 1.2 in order to guarantee the non-corner solution of the system in all possible configurations.

Figure 1: Non-corner Solution Domain



In order to prove the stability of each network configuration, we should check all possible deviations from the current structure, which is the number of possible edges in that network. If a link exists, we should check the structure in which it is not and vice versa. However, due to symmetry, the possible number of deviations is less than all possible deviations. The following figures (2, 3, 4), plots the transition graph of all unique structures for $n = 4$. That is:

- `[1H3L]`: 1 High- and 3 Low-productive firms ($\rho = 0.25$)
- `[1H3L]`: 2 High- and 2 Low-productive firms ($\rho = 0.50$)
- `[1H3L]`: 3 High- and 1 Low-productive firms ($\rho = 0.75$)

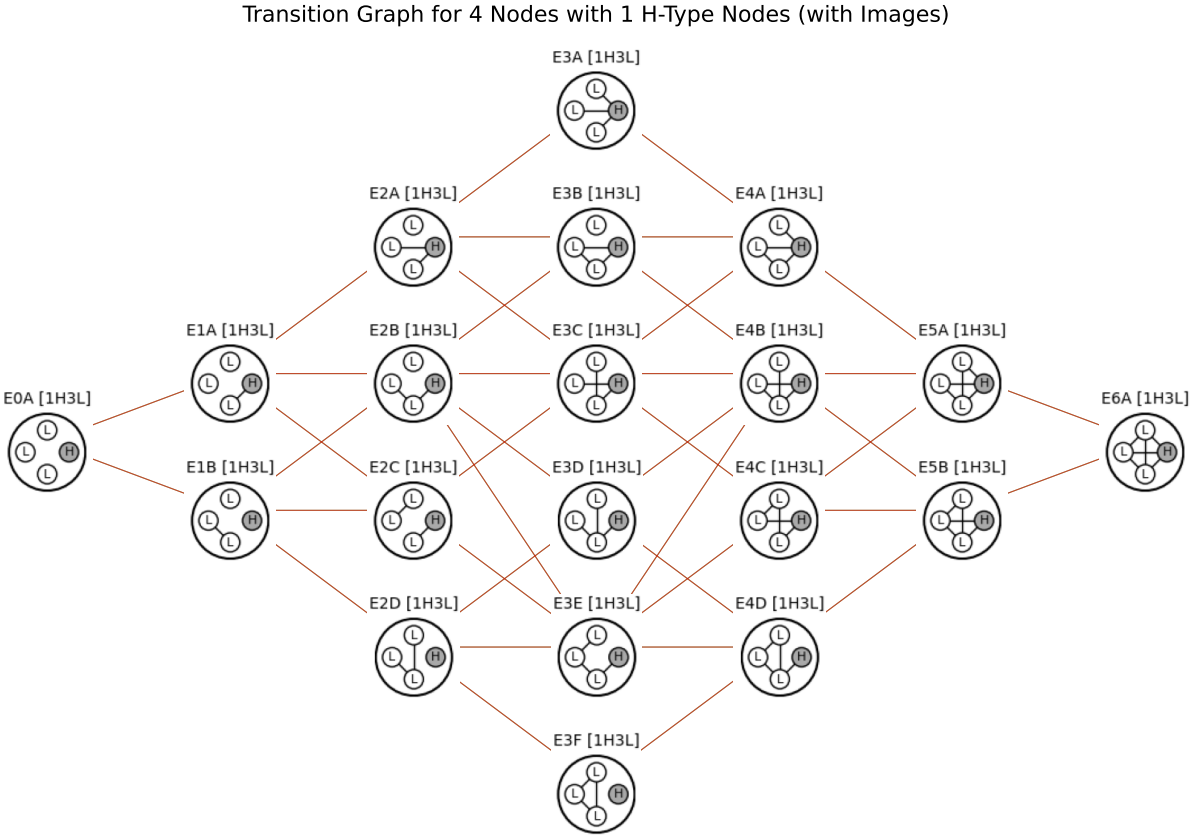


Figure 2: Transition graph for the 1H3L case.

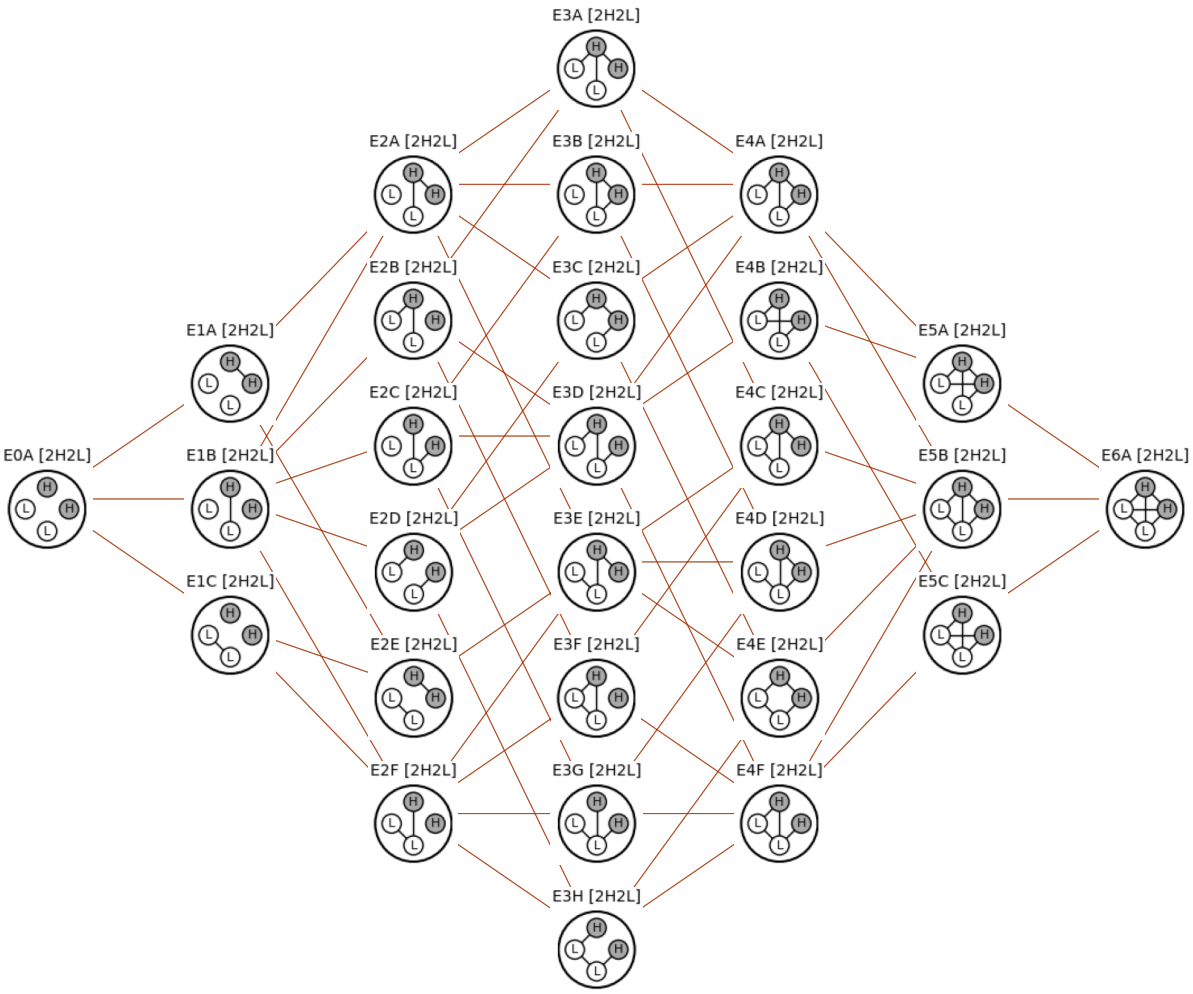


Figure 3: Transition graph for the 2H2L case.

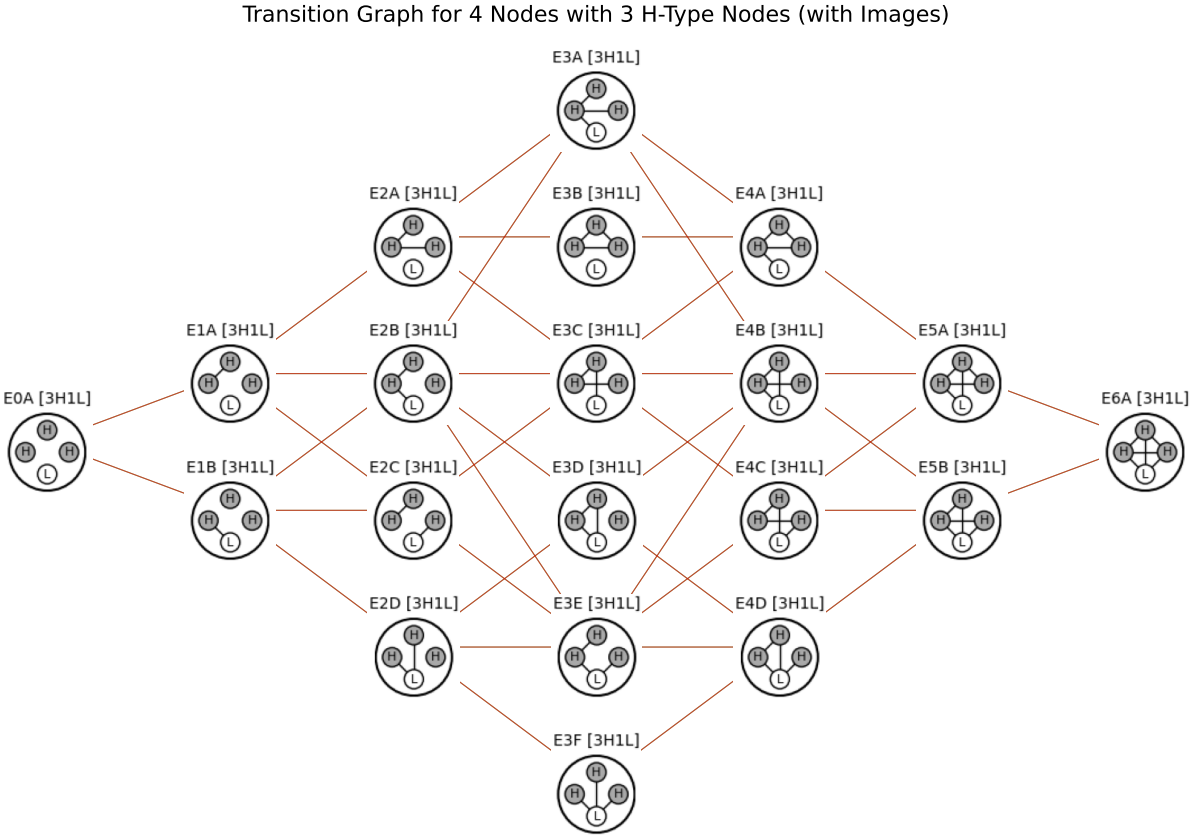


Figure 4: Transition graph for the 3H1L case.

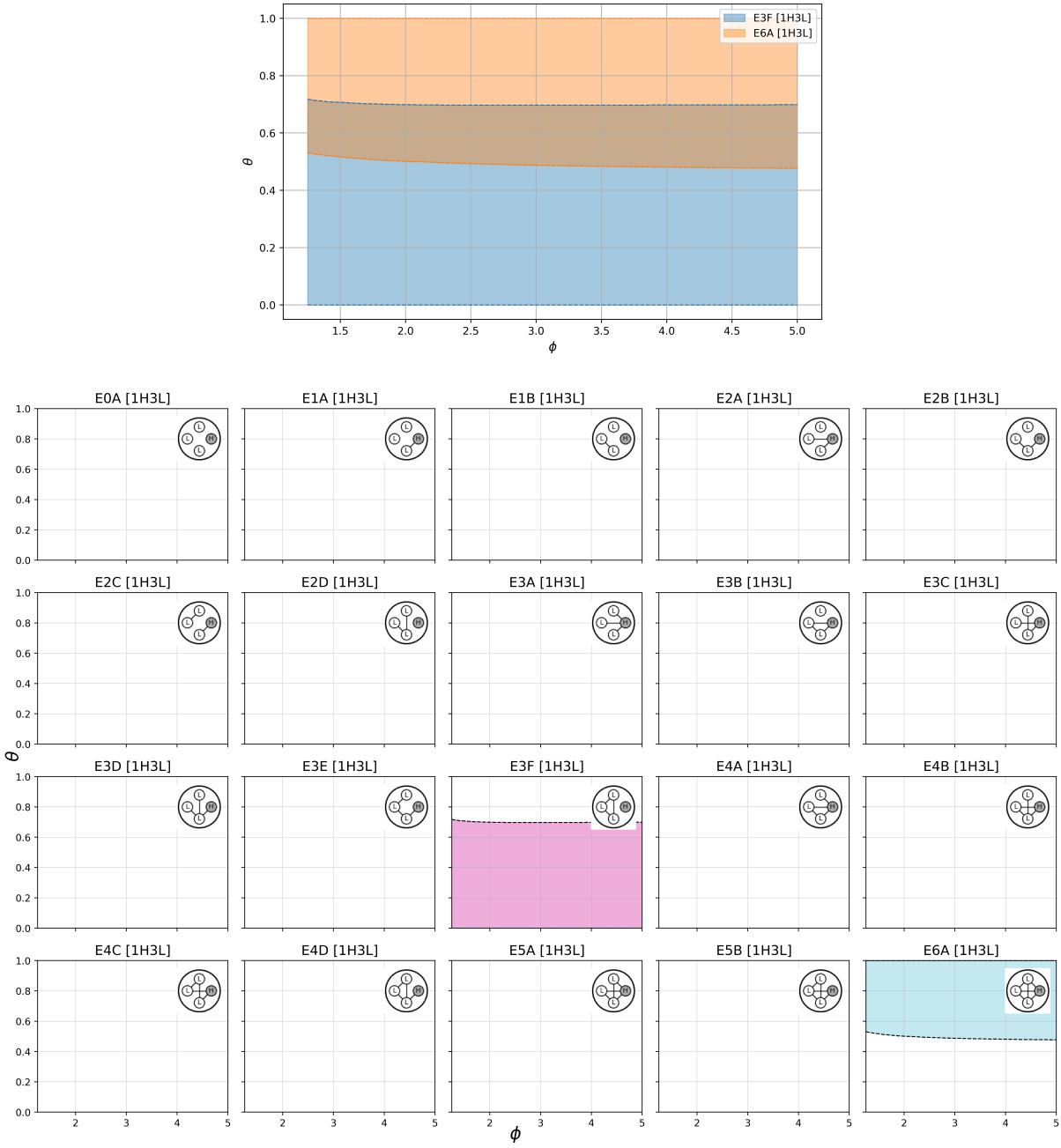


Figure 5: Stability domain (top) and full cluster visualization (bottom) for the 1H3L case.

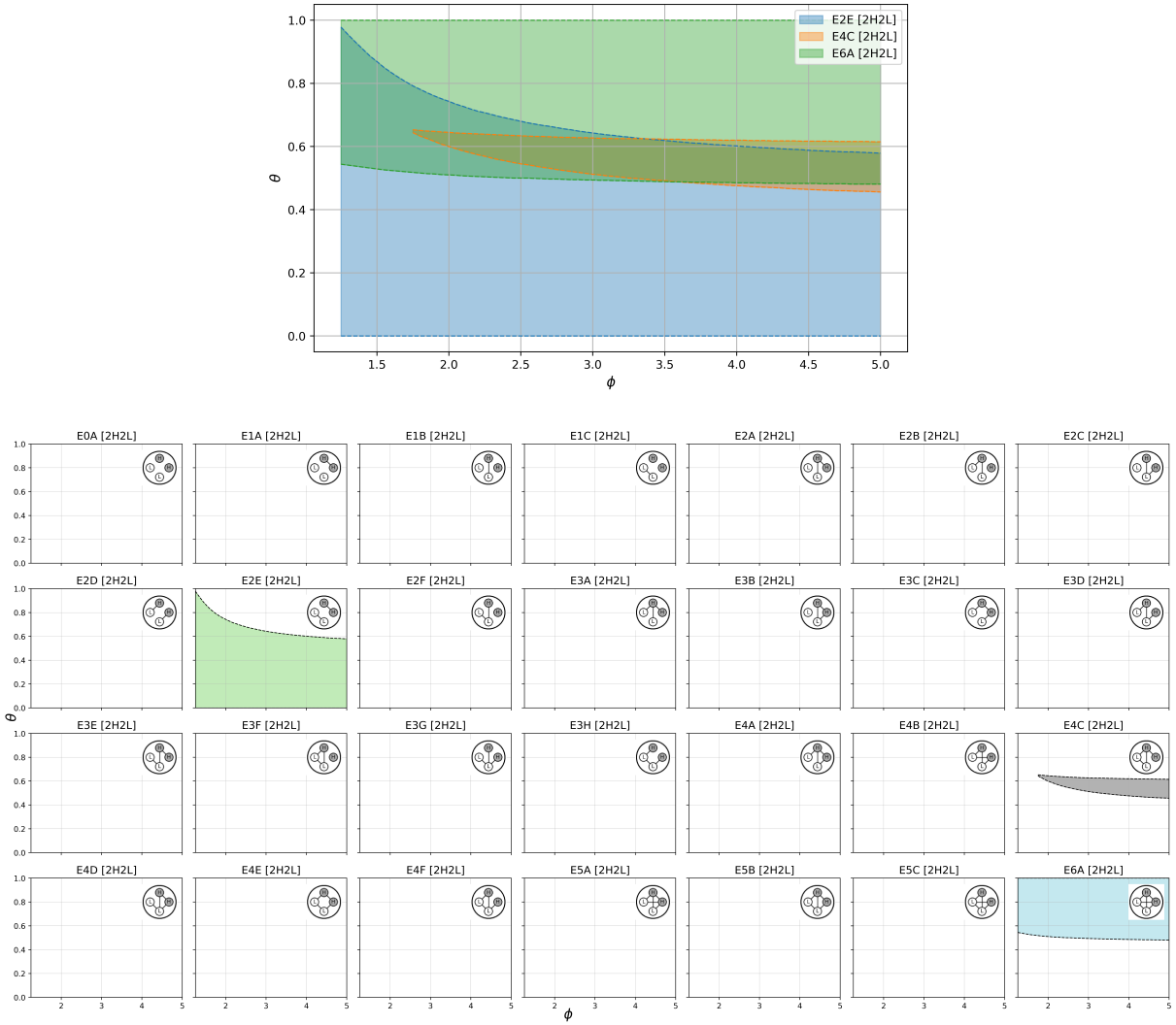


Figure 6: Stability domain (top) and full cluster visualization (bottom) for the 2H2L case.

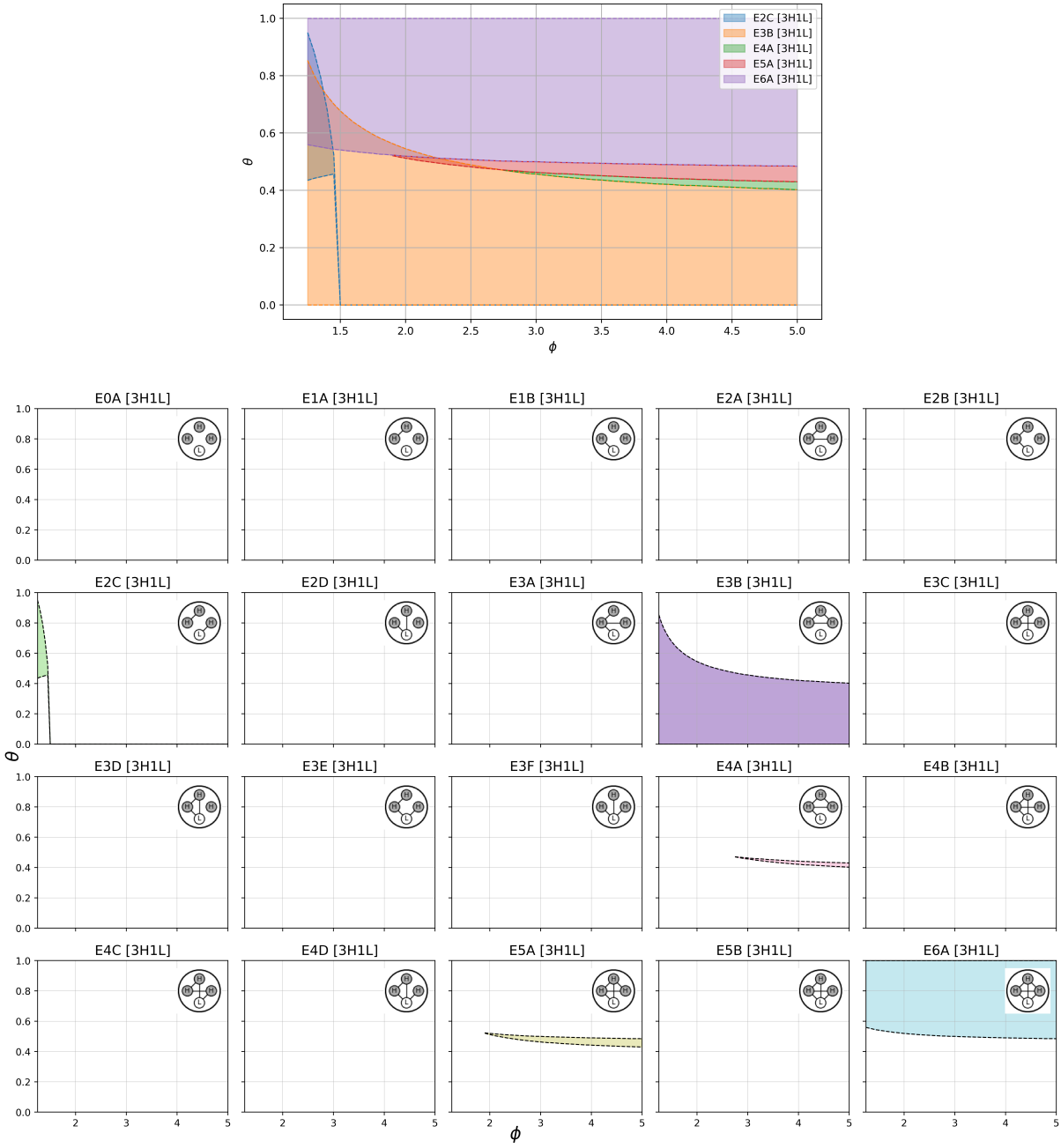


Figure 7: Stability domain (top) and full cluster visualization (bottom) for the 3H1L case.

C Stability conditions

C.1 One *high*- and three *low*-productive firms ($1H3L$)

C.1.1 Stability conditions for: E0A [1H3L]

- Adding an edge between nodes H_1, L_1: E0A [1H3L] → E1A [1H3L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-16\right)}{\left(125\phi^2-40\phi\theta^2-80\phi+16\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-16\theta^2\right)}{\left(125\phi^2-40\phi\theta^2-80\phi+16\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2\right)^2}$$

- Adding an edge between nodes L_1, L_2: E0A [1H3L] → E1B [1H3L]
  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-16\theta^2\right)}{\left(125\phi^2-40\phi\theta^2-80\phi+16\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-16\theta^2\right)}{\left(125\phi^2-40\phi\theta^2-80\phi+16\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4\right)^2}$$

C.1.2 Stability conditions for: E1A [1H3L]

- Adding an edge between nodes H_1, L_1: E1A [1H3L] → E2A [1H3L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\left(5\phi+3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(5\phi-3\theta^2-3\right)^2}{\left(125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4\right)^2}$$

- Adding an edge between nodes L_1, L_3: E1A [1H3L] → E2B [1H3L]
  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(5\phi-3\theta^2-3\right)^2}{\left(125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6\right)^2}$$

  - For L_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta\right)^2\left(5\phi+3\theta\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6\right)^2}$$

- Adding an edge between nodes L_1, L_2: E1A [1H3L] → E2C [1H3L]
  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(5\phi-3\theta^2-3\right)^2}{\left(125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(5\phi-3\theta^2-3\right)^2}{\left(125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(5\phi-3\theta^2-3\right)^2}{\left(125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(5\phi-3\theta^2-3\right)^2}{\left(125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2\right)^2}$$

- Removing an edge between nodes H_1, L_3: E1A [1H3L] → E0A [1H3L]

– For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-16\right)}{\left(125\phi^2-40\phi\theta^2-80\phi+16\theta^2\right)^2}$$

– For L_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-16\theta^2\right)}{\left(125\phi^2-40\phi\theta^2-80\phi+16\theta^2\right)^2}$$

C.1.3 Stability conditions for: E1B [1H3L]

- Adding an edge between nodes H_1, L_2: E1B [1H3L] → E2B [1H3L]
  – For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\theta^2\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-16\right)}{\left(625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6\right)^2}$$

  – For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta\right)^2\left(5\phi+3\theta\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6\right)^2}$$

- Adding an edge between nodes H_1, L_1: E1B [1H3L] → E2C [1H3L]
  – For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\theta^2\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-16\right)}{\left(625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2\right)^2}$$

  – For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-6\theta^2\right)^2\cdot\left(25\phi-16\theta^2\right)}{\left(625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2\right)^2}$$

- Adding an edge between nodes L_1, L_2: E1B [1H3L] → E2D [1H3L]
  – For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-6\theta^2\right)^2\cdot\left(25\phi-16\theta^2\right)}{\left(625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(5\phi+\theta^2\right)^2\left(125\phi^2-60\phi\theta^2-80\phi+24\theta^2\right)^2}$$

  – For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi+3\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(5\phi+\theta^2\right)^2\left(125\phi^2-60\phi\theta^2-80\phi+24\theta^2\right)^2}$$

- Removing an edge between nodes L_2, L_3: E1B [1H3L] → E0A [1H3L]
  – For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-16\theta^2\right)}{\left(125\phi^2-40\phi\theta^2-80\phi+16\theta^2\right)^2}$$

  – For L_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-16\theta^2\right)}{\left(125\phi^2-40\phi\theta^2-80\phi+16\theta^2\right)^2}$$

C.1.4 Stability conditions for: E2A [1H3L]

- Adding an edge between nodes H_1, L_1: E2A [1H3L] → E3A [1H3L]
  – For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\left(5\phi+3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+6\theta^2\right)^2\cdot\left(25\phi-1\right)}{\left(125\phi^2+15\phi\theta^2-5\phi-6\theta^2\right)^2}$$

  – For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(25\phi^2-15\phi\theta^2-10\phi-6\theta^2\right)^2}{\left(625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2+15\phi\theta^2-5\phi-6\theta^2\right)^2}$$

- Adding an edge between nodes L_2, L_3: E2A [1H3L] → E3B [1H3L]
  - For L_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2\right)^2}$$

  - For L_3 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2\right)^2}$$

- Adding an edge between nodes L_1, L_2: E2A [1H3L] → E3C [1H3L]
  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(25\phi^2-15\phi\theta^2-10\phi-6\theta^2\right)^2}{\left(625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(125\phi^3-75\phi^2\theta^2-50\phi^2+12\theta^4\right)^2}{\left(3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi\theta^2-6\theta^2\right)^2}{\left(3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6\right)^2}$$

- Removing an edge between nodes H_1, L_2: E2A [1H3L] → E1A [1H3L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\left(5\phi+3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(5\phi-3\theta^2-3\right)^2}{\left(125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2\right)^2}$$

C.1.5 Stability conditions for: E2B [1H3L]

- Adding an edge between nodes H_1, L_2: E2B [1H3L] → E3B [1H3L]
  - For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2\right)^2}$$

- Adding an edge between nodes H_1, L_1: E2B [1H3L] → E3C [1H3L]
  - For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)\left(25\phi^2-15\phi\theta^2-6\theta^4\right)^2}{\left(3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(125\phi^3-125\phi^2\theta^2-75\phi^2+45\phi\theta^2+18\theta^4\right)^2}{\left(3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(125\phi^3-125\phi^2\theta^2+12\theta^4\right)^2}{\left(3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6\right)^2}$$

- Adding an edge between nodes L_1, L_3: E2B [1H3L] → E3D [1H3L]

– For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(125\phi^3-125\phi^2\theta^2-75\phi^2+45\phi\theta^2+18\theta^4\right)^2}{\left(3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4\right)^2}$$

– For L_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta\right)^2\left(5\phi+3\theta\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2+15\phi\theta^2-18\theta^2\right)^2}{\left(625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4\right)^2}$$

- Adding an edge between nodes L_1, L_2: E2B [1H3L] → E3E [1H3L]
  – For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(125\phi^3-125\phi^2\theta^2-75\phi^2+45\phi\theta^2+18\theta^4\right)^2}{\left(3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)\left(25\phi^2-15\phi-6\theta^2\right)^2}{\left(3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6\right)^2}$$

  – For L_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi-6\theta^4\right)^2}{\left(3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6\right)^2}$$

- Removing an edge between nodes L_2, L_3: E2B [1H3L] → E1A [1H3L]
  – For L_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(5\phi-3\theta^2-3\right)^2}{\left(125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2\right)^2}$$

  – For L_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta\right)^2\left(5\phi+3\theta\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2\right)^2}$$

- Removing an edge between nodes H_1, L_3: E2B [1H3L] → E1B [1H3L]
  – For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\theta^2\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-16\right)}{\left(625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4\right)^2}$$

  – For L_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta\right)^2\left(5\phi+3\theta\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4\right)^2}$$

C.1.6 Stability conditions for: E2C [1H3L]

- Adding an edge between nodes H_1, L_1: E2C [1H3L] → E3C [1H3L]
  – For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)\left(25\phi^2-15\phi\theta^2-6\theta^4\right)^2}{\left(3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6\right)^2}$$

  – For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(5\phi-3\theta^2-3\right)^2}{\left(125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi\theta^2-6\theta^2\right)^2}{\left(3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6\right)^2}$$

- Adding an edge between nodes L_1, L_3: E2C [1H3L] → E3E [1H3L]
  – For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(5\phi-3\theta^2-3\right)^2}{\left(125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi-6\theta^4\right)^2}{\left(3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6\right)^2}$$

  – For L_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi\theta^2-6\theta^2\right)^2}{\left(3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6\right)^2}$$

- Removing an edge between nodes L_1, L_2: E2C [1H3L] → E1A [1H3L]
  - For L_1 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(5\phi-3\theta^2-3\right)^2}{\left(125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(5\phi-3\theta^2-3\right)^2}{\left(125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2\right)^2}$$
  - For L_2 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(5\phi-3\theta^2-3\right)^2}{\left(125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(5\phi-3\theta^2-3\right)^2}{\left(125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2\right)^2}$$
- Removing an edge between nodes H_1, L_3: E2C [1H3L] → E1B [1H3L]
  - For H_1 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\theta^2\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-16\right)}{\left(625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4\right)^2}$$
  - For L_3 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-6\theta^2\right)^2\cdot\left(25\phi-16\theta^2\right)}{\left(625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4\right)^2}$$

C.1.7 Stability conditions for: E2D [1H3L]

- Adding an edge between nodes H_1, L_3: E2D [1H3L] → E3D [1H3L]
  - For H_1 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\theta^2\right)^2\cdot\left(25\phi-16\right)}{\left(125\phi^2-60\phi\theta^2-80\phi+24\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4\right)^2}$$
  - For L_3 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi+3\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(5\phi+\theta^2\right)^2\left(125\phi^2-60\phi\theta^2-80\phi+24\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2+15\phi\theta^2-18\theta^2\right)^2}{\left(625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4\right)^2}$$
- Adding an edge between nodes H_1, L_1: E2D [1H3L] → E3E [1H3L]
  - For H_1 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\theta^2\right)^2\cdot\left(25\phi-16\right)}{\left(125\phi^2-60\phi\theta^2-80\phi+24\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-9\right)\left(25\phi^2-15\phi\theta^2-6\theta^4\right)^2}{\left(3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6\right)^2}$$
  - For L_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(5\phi+\theta^2\right)^2\left(125\phi^2-60\phi\theta^2-80\phi+24\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi\theta^2-6\theta^2\right)^2}{\left(3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6\right)^2}$$
- Adding an edge between nodes L_1, L_2: E2D [1H3L] → E3F [1H3L]
  - For L_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(5\phi+\theta^2\right)^2\left(125\phi^2-60\phi\theta^2-80\phi+24\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-60\phi\theta^2-80\phi+24\theta^2\right)^2}$$
  - For L_2 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(5\phi+\theta^2\right)^2\left(125\phi^2-60\phi\theta^2-80\phi+24\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-60\phi\theta^2-80\phi+24\theta^2\right)^2}$$
- Removing an edge between nodes L_1, L_3: E2D [1H3L] → E1B [1H3L]
  - For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(5\phi+\theta^2\right)^2\left(125\phi^2-60\phi\theta^2-80\phi+24\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-6\theta^2\right)^2\cdot\left(25\phi-16\theta^2\right)}{\left(625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4\right)^2}$$

– For L_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi+3\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(5\phi+\theta^2\right)^2\left(125\phi^2-60\phi\theta^2-80\phi+24\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4\right)^2}$$

C.1.8 Stability conditions for: E3A [1H3L]

- Adding an edge between nodes L_1, L_2: E3A [1H3L] → E4A [1H3L]
  - For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2+15\phi\theta^2-5\phi-6\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2+15\phi\theta^2-5\phi-6\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4\right)^2}$$

- Removing an edge between nodes H_1, L_1: E3A [1H3L] → E2A [1H3L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+6\theta^2\right)^2\cdot\left(25\phi-1\right)}{\left(125\phi^2+15\phi\theta^2-5\phi-6\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\left(5\phi+3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2+15\phi\theta^2-5\phi-6\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(25\phi^2-15\phi\theta^2-10\phi-6\theta^2\right)^2}{\left(625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4\right)^2}$$

C.1.9 Stability conditions for: E3B [1H3L]

- Adding an edge between nodes H_1, L_1: E3B [1H3L] → E4A [1H3L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)\left(25\phi^2-12\theta^4\right)^2}{\left(625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(5\phi-4\theta^2-2\right)^2}{\left(125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4\right)^2}$$

- Adding an edge between nodes L_1, L_2: E3B [1H3L] → E4B [1H3L]
  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(5\phi-4\theta^2-2\right)^2}{\left(125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(5\phi-2\theta^2-2\right)^2}{\left(625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2-6\theta^4-6\theta^2\right)^2}{\left(625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4\right)^2}$$

- Removing an edge between nodes L_2, L_3: E3B [1H3L] → E2A [1H3L]
  - For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4\right)^2}$$

  - For L_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4\right)^2}$$

- Removing an edge between nodes H_1, L_2: E3B [1H3L] → E2B [1H3L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6\right)^2}$$

C.1.10 Stability conditions for: E3C [1H3L]

- Adding an edge between nodes H_1, L_1: E3C [1H3L] → E4A [1H3L]
  - For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)\left(25\phi^2-15\phi\theta^2-6\theta^4\right)^2}{\left(3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)\left(25\phi^2-12\theta^4\right)^2}{\left(625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(125\phi^3-75\phi^2\theta^2-50\phi^2+12\theta^4\right)^2}{\left(3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4\right)^2}$$

- Adding an edge between nodes L_2, L_3: E3C [1H3L] → E4B [1H3L]
  - For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(125\phi^3-125\phi^2\theta^2+12\theta^4\right)^2}{\left(3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4\right)^2}$$

  - For L_3 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi\theta^2-6\theta^2\right)^2}{\left(3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2-6\theta^4-6\theta^2\right)^2}{\left(625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4\right)^2}$$

- Adding an edge between nodes L_1, L_2: E3C [1H3L] → E4C [1H3L]
  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(125\phi^3-75\phi^2\theta^2-50\phi^2+12\theta^4\right)^2}{\left(3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\left(5\phi+2\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-50\phi^2\theta^2-100\phi^2-40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(125\phi^3-125\phi^2\theta^2+12\theta^4\right)^2}{\left(3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-50\phi^2\theta^2-100\phi^2-40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}$$

- Removing an edge between nodes L_1, L_3: E3C [1H3L] → E2A [1H3L]
  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(125\phi^3-75\phi^2\theta^2-50\phi^2+12\theta^4\right)^2}{\left(3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(25\phi^2-15\phi\theta^2-10\phi-6\theta^2\right)^2}{\left(625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4\right)^2}$$

  - For L_3 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi\theta^2-6\theta^2\right)^2}{\left(3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4\right)^2}$$

- Removing an edge between nodes H_1, L_2: E3C [1H3L] → E2B [1H3L]

– For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)\left(25\phi^2-15\phi\theta^2-6\theta^4\right)^2}{\left(3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6\right)^2}$$

– For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(125\phi^3-125\phi^2\theta^2+12\theta^4\right)^2}{\left(3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(125\phi^3-125\phi^2\theta^2-75\phi^2+45\phi\theta^2+18\theta^4\right)^2}{\left(3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6\right)^2}$$

- Removing an edge between nodes H_1, L_3: E3C [1H3L] → E2C [1H3L]
  – For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)\left(25\phi^2-15\phi\theta^2-6\theta^4\right)^2}{\left(3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2\right)^2}$$

  – For L_3 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi\theta^2-6\theta^2\right)^2}{\left(3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(5\phi-3\theta^2-3\right)^2}{\left(125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2\right)^2}$$

C.1.11 Stability conditions for: E3D [1H3L]

- Adding an edge between nodes H_1, L_1: E3D [1H3L] → E4B [1H3L]
  – For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4\right)^2}$$

  – For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4\right)^2}$$

- Adding an edge between nodes L_1, L_2: E3D [1H3L] → E4D [1H3L]
  – For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^4\right)^2}$$

  – For L_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^4\right)^2}$$

- Removing an edge between nodes L_1, L_3: E3D [1H3L] → E2B [1H3L]
  – For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(125\phi^3-125\phi^2\theta^2-75\phi^2+45\phi\theta^2+18\theta^4\right)^2}{\left(3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6\right)^2}$$

  – For L_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2+15\phi\theta^2-18\theta^2\right)^2}{\left(625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta\right)^2\left(5\phi+3\theta\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6\right)^2}$$

- Removing an edge between nodes H_1, L_3: E3D [1H3L] → E2D [1H3L]
  – For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\theta^2\right)^2\cdot\left(25\phi-16\right)}{\left(125\phi^2-60\phi\theta^2-80\phi+24\theta^2\right)^2}$$

  – For L_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2+15\phi\theta^2-18\theta^2\right)^2}{\left(625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi+3\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(5\phi+\theta^2\right)^2\left(125\phi^2-60\phi\theta^2-80\phi+24\theta^2\right)^2}$$

C.1.12 Stability conditions for: E3E [1H3L]

- Adding an edge between nodes H_1, L_2: E3E [1H3L] → E4B [1H3L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-9\right)\left(25\phi^2-15\phi\theta^2-6\theta^4\right)^2}{\left(3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi-6\theta^4\right)^2}{\left(3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2-6\theta^4-6\theta^2\right)^2}{\left(625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4\right)^2}$$

- Adding an edge between nodes H_1, L_1: E3E [1H3L] → E4C [1H3L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-9\right)\left(25\phi^2-15\phi\theta^2-6\theta^4\right)^2}{\left(3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\left(5\phi+2\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-50\phi^2\theta^2-100\phi^2-40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)\left(25\phi^2-15\phi-6\theta^2\right)^2}{\left(3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-50\phi^2\theta^2-100\phi^2-40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}$$

- Adding an edge between nodes L_1, L_3: E3E [1H3L] → E4D [1H3L]
  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)\left(25\phi^2-15\phi-6\theta^2\right)^2}{\left(3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^4\right)^2}$$

  - For L_3 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi\theta^2-6\theta^2\right)^2}{\left(3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2-12\theta^2\right)^2}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^4\right)^2}$$

- Removing an edge between nodes L_1, L_2: E3E [1H3L] → E2B [1H3L]
  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)\left(25\phi^2-15\phi-6\theta^2\right)^2}{\left(3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(125\phi^3-125\phi^2\theta^2-75\phi^2+45\phi\theta^2+18\theta^4\right)^2}{\left(3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi-6\theta^4\right)^2}{\left(3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6\right)^2}$$

- Removing an edge between nodes L_2, L_3: E3E [1H3L] → E2C [1H3L]
  - For L_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi-6\theta^4\right)^2}{\left(3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(5\phi-3\theta^2-3\right)^2}{\left(125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2\right)^2}$$

  - For L_3 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi\theta^2-6\theta^2\right)^2}{\left(3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2\right)^2}$$

- Removing an edge between nodes H_1, L_3: E3E [1H3L] → E2D [1H3L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-9\right)\left(25\phi^2-15\phi\theta^2-6\theta^4\right)^2}{\left(3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\theta^2\right)^2\cdot\left(25\phi-16\right)}{\left(125\phi^2-60\phi\theta^2-80\phi+24\theta^2\right)^2}$$

  - For L_3 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi\theta^2-6\theta^2\right)^2}{\left(3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(5\phi+\theta^2\right)^2\left(125\phi^2-60\phi\theta^2-80\phi+24\theta^2\right)^2}$$

C.1.13 Stability conditions for: E3F [1H3L]

- Adding an edge between nodes H_1, L_1: E3F [1H3L] → E4D [1H3L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\theta^2\right)^2\cdot\left(25\phi-16\right)}{\left(125\phi^2-60\phi\theta^2-80\phi+24\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^4\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-60\phi\theta^2-80\phi+24\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2-12\theta^2\right)^2}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^4\right)^2}$$

- Removing an edge between nodes L_1, L_2: E3F [1H3L] → E2D [1H3L]
  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-60\phi\theta^2-80\phi+24\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(5\phi+\theta^2\right)^2\left(125\phi^2-60\phi\theta^2-80\phi+24\theta^2\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-60\phi\theta^2-80\phi+24\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(5\phi+\theta^2\right)^2\left(125\phi^2-60\phi\theta^2-80\phi+24\theta^2\right)^2}$$

C.1.14 Stability conditions for: E4A [1H3L]

- Adding an edge between nodes L_1, L_2: E4A [1H3L] → E5A [1H3L]
  - For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2+5\phi\theta^2-5\phi-2\theta^4-2\theta^2\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\theta^2\right)^2\cdot\left(25\phi-\theta^2\right)}{\left(125\phi^2+5\phi\theta^2-5\phi-2\theta^4-2\theta^2\right)^2}$$

- Removing an edge between nodes L_2, L_3: E4A [1H3L] → E3A [1H3L]
  - For L_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2+15\phi\theta^2-5\phi-6\theta^2\right)^2}$$

  - For L_3 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2+15\phi\theta^2-5\phi-6\theta^2\right)^2}$$

- Removing an edge between nodes H_1, L_1: E4A [1H3L] → E3B [1H3L]
  - For H_1 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)\left(25\phi^2-12\theta^4\right)^2}{\left(625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2\right)^2}$$
  - For L_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(5\phi-4\theta^2-2\right)^2}{\left(125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2\right)^2}$$
- Removing an edge between nodes H_1, L_2: E4A [1H3L] → E3C [1H3L]
  - For H_1 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)\left(25\phi^2-12\theta^4\right)^2}{\left(625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)\left(25\phi^2-15\phi\theta^2-6\theta^4\right)^2}{\left(3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6\right)^2}$$
  - For L_2 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(125\phi^3-75\phi^2\theta^2-50\phi^2+12\theta^4\right)^2}{\left(3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6\right)^2}$$

C.1.15 Stability conditions for: E4B [1H3L]

- Adding an edge between nodes H_1, L_1: E4B [1H3L] → E5A [1H3L]
  - For H_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\theta^2\right)^2\cdot\left(25\phi-1\right)}{\left(125\phi^2+5\phi\theta^2-5\phi-2\theta^4-2\theta^2\right)^2}$$
  - For L_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(5\phi-2\theta^2-2\right)^2}{\left(625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2+5\phi\theta^2-5\phi-2\theta^4-2\theta^2\right)^2}$$
- Adding an edge between nodes L_1, L_2: E4B [1H3L] → E5B [1H3L]
  - For L_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(5\phi-2\theta^2-2\right)^2}{\left(625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-150\phi^2\theta^2-100\phi^2-20\phi\theta^2+8\theta^4\right)^2}$$
  - For L_2 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-\theta^2\right)}{\left(625\phi^3-150\phi^2\theta^2-100\phi^2-20\phi\theta^2+8\theta^4\right)^2}$$
- Removing an edge between nodes L_1, L_3: E4B [1H3L] → E3B [1H3L]
  - For L_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(5\phi-2\theta^2-2\right)^2}{\left(625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(5\phi-4\theta^2-2\right)^2}{\left(125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2\right)^2}$$
  - For L_3 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2-6\theta^4-6\theta^2\right)^2}{\left(625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2\right)^2}$$
- Removing an edge between nodes L_2, L_3: E4B [1H3L] → E3C [1H3L]
  - For L_2 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(125\phi^3-125\phi^2\theta^2+12\theta^4\right)^2}{\left(3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6\right)^2}$$
  - For L_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2-6\theta^4-6\theta^2\right)^2}{\left(625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi\theta^2-6\theta^2\right)^2}{\left(3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6\right)^2}$$

- Removing an edge between nodes H_1, L_2: E4B [1H3L] → E3D [1H3L]
  - For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4\right)^2}$$

- Removing an edge between nodes H_1, L_3: E4B [1H3L] → E3E [1H3L]
  - For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-9\right)\left(25\phi^2-15\phi\theta^2-6\theta^4\right)^2}{\left(3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6\right)^2}$$

  - For L_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2-6\theta^4-6\theta^2\right)^2}{\left(625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi-6\theta^4\right)^2}{\left(3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6\right)^2}$$

C.1.16 Stability conditions for: E4C [1H3L]

- Adding an edge between nodes H_1, L_1: E4C [1H3L] → E5A [1H3L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\left(5\phi+2\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-50\phi^2\theta^2-100\phi^2-40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\theta^2\right)^2\cdot\left(25\phi-1\right)}{\left(125\phi^2+5\phi\theta^2-5\phi-2\theta^4-2\theta^2\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\left(5\phi+2\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-50\phi^2\theta^2-100\phi^2-40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\theta^2\right)^2\cdot\left(25\phi-\theta^2\right)}{\left(125\phi^2+5\phi\theta^2-5\phi-2\theta^4-2\theta^2\right)^2}$$

- Adding an edge between nodes L_2, L_3: E4C [1H3L] → E5B [1H3L]
  - For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-50\phi^2\theta^2-100\phi^2-40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-\theta^2\right)}{\left(625\phi^3-150\phi^2\theta^2-100\phi^2-20\phi\theta^2+8\theta^4\right)^2}$$

  - For L_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-50\phi^2\theta^2-100\phi^2-40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-\theta^2\right)}{\left(625\phi^3-150\phi^2\theta^2-100\phi^2-20\phi\theta^2+8\theta^4\right)^2}$$

- Removing an edge between nodes L_1, L_2: E4C [1H3L] → E3C [1H3L]
  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\left(5\phi+2\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-50\phi^2\theta^2-100\phi^2-40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(125\phi^3-75\phi^2\theta^2-50\phi^2+12\theta^4\right)^2}{\left(3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-50\phi^2\theta^2-100\phi^2-40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(125\phi^3-125\phi^2\theta^2+12\theta^4\right)^2}{\left(3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6\right)^2}$$

- Removing an edge between nodes H_1, L_2: E4C [1H3L] → E3E [1H3L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\left(5\phi+2\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-50\phi^2\theta^2-100\phi^2-40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-9\right)\left(25\phi^2-15\phi\theta^2-6\theta^4\right)^2}{\left(3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6\right)^2}$$

– For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-50\phi^2\theta^2-100\phi^2-40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)\left(25\phi^2-15\phi-6\theta^2\right)^2}{\left(3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6\right)^2}$$

C.1.17 Stability conditions for: E4D [1H3L]

- Adding an edge between nodes H_1, L_1: E4D [1H3L] → E5B [1H3L]
  - For H_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^4\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-150\phi^2\theta^2-100\phi^2-20\phi\theta^2+8\theta^4\right)^2}$$
  - For L_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-\theta^2\right)}{\left(625\phi^3-150\phi^2\theta^2-100\phi^2-20\phi\theta^2+8\theta^4\right)^2}$$
- Removing an edge between nodes L_1, L_2: E4D [1H3L] → E3D [1H3L]
  - For L_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^4\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4\right)^2}$$
  - For L_2 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^4\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4\right)^2}$$
- Removing an edge between nodes L_1, L_3: E4D [1H3L] → E3E [1H3L]
  - For L_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)\left(25\phi^2-15\phi-6\theta^2\right)^2}{\left(3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6\right)^2}$$
  - For L_3 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2-12\theta^2\right)^2}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^4\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi\theta^2-6\theta^2\right)^2}{\left(3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6\right)^2}$$
- Removing an edge between nodes H_1, L_3: E4D [1H3L] → E3F [1H3L]
  - For H_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\theta^2\right)^2\cdot\left(25\phi-16\right)}{\left(125\phi^2-60\phi\theta^2-80\phi+24\theta^2\right)^2}$$
  - For L_3 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2-12\theta^2\right)^2}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-60\phi\theta^2-80\phi+24\theta^2\right)^2}$$

C.1.18 Stability conditions for: E5A [1H3L]

- Adding an edge between nodes L_1, L_2: E5A [1H3L] → E6A [1H3L]
  - For L_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2+5\phi\theta^2-5\phi-2\theta^4-2\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)}{\left(25\phi-3\theta^2-1\right)^2}$$

- For L_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2+5\phi\theta^2-5\phi-2\theta^4-2\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)}{\left(25\phi-3\theta^2-1\right)^2}$$

- Removing an edge between nodes L_1, L_3: E5A [1H3L] → E4A [1H3L]
  - For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2+5\phi\theta^2-5\phi-2\theta^4-2\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4\right)^2}$$

  - For L_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\theta^2\right)^2\cdot\left(25\phi-\theta^2\right)}{\left(125\phi^2+5\phi\theta^2-5\phi-2\theta^4-2\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4\right)^2}$$

- Removing an edge between nodes H_1, L_1: E5A [1H3L] → E4B [1H3L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\theta^2\right)^2\cdot\left(25\phi-1\right)}{\left(125\phi^2+5\phi\theta^2-5\phi-2\theta^4-2\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2+5\phi\theta^2-5\phi-2\theta^4-2\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(5\phi-2\theta^2-2\right)^2}{\left(625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4\right)^2}$$

- Removing an edge between nodes H_1, L_3: E5A [1H3L] → E4C [1H3L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\theta^2\right)^2\cdot\left(25\phi-1\right)}{\left(125\phi^2+5\phi\theta^2-5\phi-2\theta^4-2\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\left(5\phi+2\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-50\phi^2\theta^2-100\phi^2-40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}$$

  - For L_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\theta^2\right)^2\cdot\left(25\phi-\theta^2\right)}{\left(125\phi^2+5\phi\theta^2-5\phi-2\theta^4-2\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\left(5\phi+2\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-50\phi^2\theta^2-100\phi^2-40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}$$

C.1.19 Stability conditions for: E5B [1H3L]

- Adding an edge between nodes H_1, L_1: E5B [1H3L] → E6A [1H3L]
  - For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-150\phi^2\theta^2-100\phi^2-20\phi\theta^2+8\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)}{\left(25\phi-3\theta^2-1\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-150\phi^2\theta^2-100\phi^2-20\phi\theta^2+8\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)}{\left(25\phi-3\theta^2-1\right)^2}$$

- Removing an edge between nodes L_1, L_2: E5B [1H3L] → E4B [1H3L]
  - For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-150\phi^2\theta^2-100\phi^2-20\phi\theta^2+8\theta^4\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(5\phi-2\theta^2-2\right)^2}{\left(625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-\theta^2\right)}{\left(625\phi^3-150\phi^2\theta^2-100\phi^2-20\phi\theta^2+8\theta^4\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4\right)^2}$$

- Removing an edge between nodes L_2, L_3: E5B [1H3L] → E4C [1H3L]
  - For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^{2}\left(5\phi-2\theta\right)^{2}\left(5\phi+2\theta\right)^{2}\cdot\left(25\phi-\theta^{2}\right)}{\left(625\phi^{3}-150\phi^{2}\theta^{2}-100\phi^{2}-20\phi\theta^{2}+8\theta^{4}\right)^{2}}\geq\frac{\phi\left(\alpha-\bar{c}\right)^{2}\left(5\phi-2\theta\right)^{2}\left(5\phi+2\theta\right)^{2}\cdot\left(25\phi-4\theta^{2}\right)}{\left(625\phi^{3}-50\phi^{2}\theta^{2}-100\phi^{2}-40\phi\theta^{4}-60\phi\theta^{2}+24\theta^{4}\right)^{2}}$$

  - For L_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^{2}\left(5\phi-2\theta\right)^{2}\left(5\phi+2\theta\right)^{2}\cdot\left(25\phi-\theta^{2}\right)}{\left(625\phi^{3}-150\phi^{2}\theta^{2}-100\phi^{2}-20\phi\theta^{2}+8\theta^{4}\right)^{2}}\geq\frac{\phi\left(\alpha-\bar{c}\right)^{2}\left(5\phi-2\theta\right)^{2}\left(5\phi+2\theta\right)^{2}\cdot\left(25\phi-4\theta^{2}\right)}{\left(625\phi^{3}-50\phi^{2}\theta^{2}-100\phi^{2}-40\phi\theta^{4}-60\phi\theta^{2}+24\theta^{4}\right)^{2}}$$

- Removing an edge between nodes H_1, L_2: E5B [1H3L] → E4D [1H3L]
  - For H_1 not to be profitable:

$$\frac{25\phi^{3}\left(\alpha-\bar{c}\right)^{2}\left(5\phi-2\theta^{2}\right)^{2}\cdot\left(25\phi-4\right)}{\left(625\phi^{3}-150\phi^{2}\theta^{2}-100\phi^{2}-20\phi\theta^{2}+8\theta^{4}\right)^{2}}\geq\frac{25\phi^{3}\left(\alpha-\bar{c}\right)^{2}\left(5\phi-4\theta^{2}\right)^{2}\cdot\left(25\phi-9\right)}{\left(625\phi^{3}-225\phi^{2}\theta^{2}-225\phi^{2}+12\theta^{4}\right)^{2}}$$

  - For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^{2}\left(5\phi-2\theta\right)^{2}\left(5\phi+2\theta\right)^{2}\cdot\left(25\phi-\theta^{2}\right)}{\left(625\phi^{3}-150\phi^{2}\theta^{2}-100\phi^{2}-20\phi\theta^{2}+8\theta^{4}\right)^{2}}\geq\frac{25\phi^{3}\left(\alpha-\bar{c}\right)^{2}\left(5\phi-3\right)^{2}\cdot\left(25\phi-4\theta^{2}\right)}{\left(625\phi^{3}-225\phi^{2}\theta^{2}-225\phi^{2}+12\theta^{4}\right)^{2}}$$

C.1.20 Stability conditions for: E6A [1H3L]

- Removing an edge between nodes L_1, L_2: E6A [1H3L] → E5A [1H3L]
  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^{2}\cdot\left(25\phi-\theta^{2}\right)}{\left(25\phi-3\theta^{2}-1\right)^{2}}\geq\frac{25\phi^{3}\left(\alpha-\bar{c}\right)^{2}\cdot\left(25\phi-4\theta^{2}\right)}{\left(125\phi^{2}+5\phi\theta^{2}-5\phi-2\theta^{4}-2\theta^{2}\right)^{2}}$$

  - For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^{2}\cdot\left(25\phi-\theta^{2}\right)}{\left(25\phi-3\theta^{2}-1\right)^{2}}\geq\frac{25\phi^{3}\left(\alpha-\bar{c}\right)^{2}\cdot\left(25\phi-4\theta^{2}\right)}{\left(125\phi^{2}+5\phi\theta^{2}-5\phi-2\theta^{4}-2\theta^{2}\right)^{2}}$$

- Removing an edge between nodes H_1, L_1: E6A [1H3L] → E5B [1H3L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^{2}\cdot\left(25\phi-1\right)}{\left(25\phi-3\theta^{2}-1\right)^{2}}\geq\frac{25\phi^{3}\left(\alpha-\bar{c}\right)^{2}\left(5\phi-2\theta^{2}\right)^{2}\cdot\left(25\phi-4\right)}{\left(625\phi^{3}-150\phi^{2}\theta^{2}-100\phi^{2}-20\phi\theta^{2}+8\theta^{4}\right)^{2}}$$

  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^{2}\cdot\left(25\phi-\theta^{2}\right)}{\left(25\phi-3\theta^{2}-1\right)^{2}}\geq\frac{25\phi^{3}\left(\alpha-\bar{c}\right)^{2}\left(5\phi-2\right)^{2}\cdot\left(25\phi-4\theta^{2}\right)}{\left(625\phi^{3}-150\phi^{2}\theta^{2}-100\phi^{2}-20\phi\theta^{2}+8\theta^{4}\right)^{2}}$$

C.2 Two *high*- and two *low*-productive firms ($2H2L$)

C.2.1 Stability conditions for: E0A [2H2L]

- Adding an edge between nodes H_1, H_2: E0A [2H2L] → E1A [2H2L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-16\right)}{\left(125\phi^2-60\phi\theta^2-60\phi+16\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-60\phi\theta^2-90\phi+24\theta^2\right)^2}$$

  - For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-16\right)}{\left(125\phi^2-60\phi\theta^2-60\phi+16\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-60\phi\theta^2-90\phi+24\theta^2\right)^2}$$

- Adding an edge between nodes H_1, L_1: E0A [2H2L] → E1B [2H2L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-16\right)}{\left(125\phi^2-60\phi\theta^2-60\phi+16\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-16\theta^2\right)}{\left(125\phi^2-60\phi\theta^2-60\phi+16\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2\right)^2}$$

- Adding an edge between nodes L_1, L_2: E0A [2H2L] → E1C [2H2L]
  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-16\theta^2\right)}{\left(125\phi^2-60\phi\theta^2-60\phi+16\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2-90\phi\theta^2-60\phi+24\theta^2\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-16\theta^2\right)}{\left(125\phi^2-60\phi\theta^2-60\phi+16\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2-90\phi\theta^2-60\phi+24\theta^2\right)^2}$$

C.2.2 Stability conditions for: E1A [2H2L]

- Adding an edge between nodes H_1, L_1: E1A [2H2L] → E2A [2H2L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-60\phi\theta^2-90\phi+24\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta\right)^2\left(5\phi+3\theta\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\right)^2\cdot\left(25\phi-16\theta^2\right)}{\left(125\phi^2-60\phi\theta^2-90\phi+24\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4\right)^2}$$

- Adding an edge between nodes L_1, L_2: E1A [2H2L] → E2E [2H2L]
  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\right)^2\cdot\left(25\phi-16\theta^2\right)}{\left(125\phi^2-60\phi\theta^2-90\phi+24\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2-90\phi\theta^2-90\phi+36\theta^2\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\right)^2\cdot\left(25\phi-16\theta^2\right)}{\left(125\phi^2-60\phi\theta^2-90\phi+24\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2-90\phi\theta^2-90\phi+36\theta^2\right)^2}$$

- Removing an edge between nodes H_1, H_2: E1A [2H2L] → E0A [2H2L]

– For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-60\phi\theta^2-90\phi+24\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-16\right)}{\left(125\phi^2-60\phi\theta^2-60\phi+16\theta^2\right)^2}$$

– For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-60\phi\theta^2-90\phi+24\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-16\right)}{\left(125\phi^2-60\phi\theta^2-60\phi+16\theta^2\right)^2}$$

C.2.3 Stability conditions for: E1B [2H2L]

- Adding an edge between nodes H_1, H_2: E1B [2H2L] → E2A [2H2L]
  – For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-16\right)\left(5\phi-3\theta^2-3\right)^2}{\left(625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4\right)^2}$$

  – For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta\right)^2\left(5\phi+3\theta\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4\right)^2}$$

- Adding an edge between nodes H_2, L_1: E1B [2H2L] → E2B [2H2L]
  – For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi+3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2\right)^2}$$

  – For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-16\theta^2\right)\left(5\phi-3\theta^2-3\right)^2}{\left(625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2\right)^2}$$

- Adding an edge between nodes H_1, L_2: E1B [2H2L] → E2C [2H2L]
  – For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-16\right)\left(5\phi-3\theta^2-3\right)^2}{\left(625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}$$

  – For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+3\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}$$

- Adding an edge between nodes H_1, L_1: E1B [2H2L] → E2D [2H2L]
  – For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-16\right)\left(5\phi-3\theta^2-3\right)^2}{\left(625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)}{\left(25\phi-3\theta^2-3\right)^2}$$

  – For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-16\theta^2\right)\left(5\phi-3\theta^2-3\right)^2}{\left(625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(25\phi-3\theta^2-3\right)^2}$$

- Adding an edge between nodes L_1, L_2: E1B [2H2L] → E2F [2H2L]
  – For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-16\theta^2\right)\left(5\phi-3\theta^2-3\right)^2}{\left(625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4\right)^2}$$

  – For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-3\theta\right)^2\left(5\phi+3\theta\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4\right)^2}$$

- Removing an edge between nodes H_2, L_2: E1B [2H2L] → E0A [2H2L]
  - For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-16\right)}{\left(125\phi^2-60\phi\theta^2-60\phi+16\theta^2\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-16\theta^2\right)}{\left(125\phi^2-60\phi\theta^2-60\phi+16\theta^2\right)^2}$$

C.2.4 Stability conditions for: E1C [2H2L]

- Adding an edge between nodes H_1, H_2: E1C [2H2L] → E2E [2H2L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\theta^2\right)^2\cdot\left(25\phi-16\right)}{\left(125\phi^2-90\phi\theta^2-60\phi+24\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-90\phi\theta^2-90\phi+36\theta^2\right)^2}$$

  - For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\theta^2\right)^2\cdot\left(25\phi-16\right)}{\left(125\phi^2-90\phi\theta^2-60\phi+24\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-90\phi\theta^2-90\phi+36\theta^2\right)^2}$$

- Adding an edge between nodes H_1, L_1: E1C [2H2L] → E2F [2H2L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\theta^2\right)^2\cdot\left(25\phi-16\right)}{\left(125\phi^2-90\phi\theta^2-60\phi+24\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2-90\phi\theta^2-60\phi+24\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-3\theta\right)^2\left(5\phi+3\theta\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4\right)^2}$$

- Removing an edge between nodes L_1, L_2: E1C [2H2L] → E0A [2H2L]
  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2-90\phi\theta^2-60\phi+24\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-16\theta^2\right)}{\left(125\phi^2-60\phi\theta^2-60\phi+16\theta^2\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2-90\phi\theta^2-60\phi+24\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-16\theta^2\right)}{\left(125\phi^2-60\phi\theta^2-60\phi+16\theta^2\right)^2}$$

C.2.5 Stability conditions for: E2A [2H2L]

- Adding an edge between nodes H_2, L_1: E2A [2H2L] → E3A [2H2L]
  - For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta\right)^2\left(5\phi+3\theta\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)\left(25\phi^2+15\phi\theta^2-18\theta^2\right)^2}{\left(625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(125\phi^3-75\phi^2\theta^2-125\phi^2+45\phi\theta^2+18\theta^2\right)^2}{\left(3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2\right)^2}$$

- Adding an edge between nodes H_1, L_2: E2A [2H2L] → E3B [2H2L]
  - For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2\right)^2}$$

- Adding an edge between nodes H_1, L_1: E2A [2H2L] → E3C [2H2L]
  - For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-15\phi\theta^2-40\phi+6\theta^2\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(125\phi^3-75\phi^2\theta^2-125\phi^2+45\phi\theta^2+18\theta^2\right)^2}{\left(3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2-15\phi\theta^2-40\phi+6\theta^2\right)^2}$$

- Adding an edge between nodes L_1, L_2: E2A [2H2L] → E3E [2H2L]
  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(125\phi^3-75\phi^2\theta^2-125\phi^2+45\phi\theta^2+18\theta^2\right)^2}{\left(3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(125\phi^3-125\phi^2+12\theta^2\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi-6\theta^2\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}$$

- Removing an edge between nodes H_2, L_2: E2A [2H2L] → E1A [2H2L]
  - For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta\right)^2\left(5\phi+3\theta\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-60\phi\theta^2-90\phi+24\theta^2\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\right)^2\cdot\left(25\phi-16\theta^2\right)}{\left(125\phi^2-60\phi\theta^2-90\phi+24\theta^2\right)^2}$$

- Removing an edge between nodes H_1, H_2: E2A [2H2L] → E1B [2H2L]
  - For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-16\right)\left(5\phi-3\theta^2-3\right)^2}{\left(625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2\right)^2}$$

  - For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta\right)^2\left(5\phi+3\theta\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2\right)^2}$$

C.2.6 Stability conditions for: E2B [2H2L]

- Adding an edge between nodes H_1, H_2: E2B [2H2L] → E3A [2H2L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\right)\left(25\phi^2-15\phi\theta^2-10\phi-6\theta^2\right)^2}{\left(625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2\right)^2}$$

  - For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi+3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)\left(25\phi^2+15\phi\theta^2-18\theta^2\right)^2}{\left(625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2\right)^2}$$

- Adding an edge between nodes H_1, L_1: E2B [2H2L] → E3D [2H2L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\right)\left(25\phi^2-15\phi\theta^2-10\phi-6\theta^2\right)^2}{\left(625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)\left(125\phi^3-75\phi^2\theta^2-50\phi^2+12\theta^4\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi\theta^2-6\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}$$

- Adding an edge between nodes L_1, L_2: E2B [2H2L] → E3F [2H2L]
  - For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8\right)^2}$$

- Removing an edge between nodes H_2, L_1: E2B [2H2L] → E1B [2H2L]
  - For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi+3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-16\theta^2\right)\left(5\phi-3\theta^2-3\right)^2}{\left(625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2\right)^2}$$

C.2.7 Stability conditions for: E2C [2H2L]

- Adding an edge between nodes H_1, H_2: E2C [2H2L] → E3B [2H2L]
  - For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2\right)^2}$$

  - For H_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2\right)^2}$$

- Adding an edge between nodes H_1, L_1: E2C [2H2L] → E3D [2H2L]
  - For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)\left(25\phi^2-15\phi-6\theta^4\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}$$

– For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(25\phi^2-10\phi\theta^2-15\phi-6\theta^2\right)^2}{\left(625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(125\phi^3-50\phi^2\theta^2-75\phi^2+12\theta^2\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}$$

- Adding an edge between nodes L_1, L_2: E2C [2H2L] → E3G [2H2L]
  - For L_1 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(25\phi^2-10\phi\theta^2-15\phi-6\theta^2\right)^2}{\left(625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4\right)^2}$$
  - For L_2 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+3\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2+15\phi-18\theta^2\right)^2}{\left(625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4\right)^2}$$
- Removing an edge between nodes H_1, L_2: E2C [2H2L] → E1B [2H2L]
  - For H_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-16\right)\left(5\phi-3\theta^2-3\right)^2}{\left(625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2\right)^2}$$
  - For L_2 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+3\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2\right)^2}$$

C.2.8 Stability conditions for: E2D [2H2L]

- Adding an edge between nodes H_1, H_2: E2D [2H2L] → E3C [2H2L]
  - For H_1 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)}{\left(25\phi-3\theta^2-3\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-15\phi\theta^2-40\phi+6\theta^2\right)^2}$$
  - For H_2 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)}{\left(25\phi-3\theta^2-3\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-15\phi\theta^2-40\phi+6\theta^2\right)^2}$$
- Adding an edge between nodes H_1, L_1: E2D [2H2L] → E3D [2H2L]
  - For H_1 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)}{\left(25\phi-3\theta^2-3\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)\left(25\phi^2-15\phi-6\theta^4\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}$$
  - For L_1 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(25\phi-3\theta^2-3\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi\theta^2-6\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}$$
- Adding an edge between nodes L_1, L_2: E2D [2H2L] → E3H [2H2L]
  - For L_1 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(25\phi-3\theta^2-3\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-40\phi\theta^2-15\phi+6\theta^2\right)^2}$$
  - For L_2 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(25\phi-3\theta^2-3\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-40\phi\theta^2-15\phi+6\theta^2\right)^2}$$

- Removing an edge between nodes H_1, L_2: E2D [2H2L] → E1B [2H2L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)}{\left(25\phi-3\theta^2-3\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-16\right)\left(5\phi-3\theta^2-3\right)^2}{\left(625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(25\phi-3\theta^2-3\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-16\theta^2\right)\left(5\phi-3\theta^2-3\right)^2}{\left(625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2\right)^2}$$

C.2.9 Stability conditions for: E2E [2H2L]

- Adding an edge between nodes H_1, L_1: E2E [2H2L] → E3E [2H2L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-90\phi\theta^2-90\phi+36\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)\left(25\phi^2-15\phi\theta^2-6\theta^2\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2-90\phi\theta^2-90\phi+36\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi-6\theta^2\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}$$

- Removing an edge between nodes L_1, L_2: E2E [2H2L] → E1A [2H2L]
  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2-90\phi\theta^2-90\phi+36\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\right)^2\cdot\left(25\phi-16\theta^2\right)}{\left(125\phi^2-60\phi\theta^2-90\phi+24\theta^2\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2-90\phi\theta^2-90\phi+36\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\right)^2\cdot\left(25\phi-16\theta^2\right)}{\left(125\phi^2-60\phi\theta^2-90\phi+24\theta^2\right)^2}$$

- Removing an edge between nodes H_1, H_2: E2E [2H2L] → E1C [2H2L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-90\phi\theta^2-90\phi+36\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\theta^2\right)^2\cdot\left(25\phi-16\right)}{\left(125\phi^2-90\phi\theta^2-60\phi+24\theta^2\right)^2}$$

  - For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-90\phi\theta^2-90\phi+36\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\theta^2\right)^2\cdot\left(25\phi-16\right)}{\left(125\phi^2-90\phi\theta^2-60\phi+24\theta^2\right)^2}$$

C.2.10 Stability conditions for: E2F [2H2L]

- Adding an edge between nodes H_1, H_2: E2F [2H2L] → E3E [2H2L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\right)\left(125\phi^3-125\phi^2\theta^2-75\phi^2+45\phi\theta^2+18\theta^4\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)\left(125\phi^3-125\phi^2\theta^2+12\theta^4\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}$$

  - For H_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)\left(25\phi^2-15\phi\theta^2-6\theta^2\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}$$

- Adding an edge between nodes H_2, L_1: E2F [2H2L] → E3F [2H2L]
  - For H_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8\right)^2}$$

– For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8\right)^2}$$

- Adding an edge between nodes H_1, L_2: E2F [2H2L] → E3G [2H2L]
  – For H_1 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\right)\left(125\phi^3-125\phi^2\theta^2-75\phi^2+45\phi\theta^2+18\theta^4\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4\right)^2}$$
  – For L_2 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-3\theta\right)^2\left(5\phi+3\theta\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2+15\phi-18\theta^2\right)^2}{\left(625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4\right)^2}$$
- Adding an edge between nodes H_1, L_1: E2F [2H2L] → E3H [2H2L]
  – For H_1 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\right)\left(125\phi^3-125\phi^2\theta^2-75\phi^2+45\phi\theta^2+18\theta^4\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-40\phi\theta^2-15\phi+6\theta^2\right)^2}$$
  – For L_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-40\phi\theta^2-15\phi+6\theta^2\right)^2}$$
- Removing an edge between nodes L_1, L_2: E2F [2H2L] → E1B [2H2L]
  – For L_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-16\theta^2\right)\left(5\phi-3\theta^2-3\right)^2}{\left(625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2\right)^2}$$
  – For L_2 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-3\theta\right)^2\left(5\phi+3\theta\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2\right)^2}$$
- Removing an edge between nodes H_2, L_2: E2F [2H2L] → E1C [2H2L]
  – For H_2 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\theta^2\right)^2\cdot\left(25\phi-16\right)}{\left(125\phi^2-90\phi\theta^2-60\phi+24\theta^2\right)^2}$$
  – For L_2 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-3\theta\right)^2\left(5\phi+3\theta\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2-90\phi\theta^2-60\phi+24\theta^2\right)^2}$$

C.2.11 Stability conditions for: E3A [2H2L]

- Adding an edge between nodes H_1, L_1: E3A [2H2L] → E4A [2H2L]
  – For H_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2\right)^2}$$
  – For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2\right)^2}$$

- Adding an edge between nodes L_1, L_2: E3A [2H2L] → E4C [2H2L]
  - For L_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2\right)^2}$$
  - For L_2 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2\right)^2}$$
- Removing an edge between nodes H_2, L_1: E3A [2H2L] → E2A [2H2L]
  - For H_2 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)\left(25\phi^2+15\phi\theta^2-18\theta^2\right)^2}{\left(625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta\right)^2\left(5\phi+3\theta\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4\right)^2}$$
  - For L_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(125\phi^3-75\phi^2\theta^2-125\phi^2+45\phi\theta^2+18\theta^2\right)^2}{\left(3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4\right)^2}$$
- Removing an edge between nodes H_1, H_2: E3A [2H2L] → E2B [2H2L]
  - For H_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\right)\left(25\phi^2-15\phi\theta^2-10\phi-6\theta^2\right)^2}{\left(625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2\right)^2}$$
  - For H_2 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)\left(25\phi^2+15\phi\theta^2-18\theta^2\right)^2}{\left(625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi+3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2\right)^2}$$

C.2.12 Stability conditions for: E3B [2H2L]

- Adding an edge between nodes H_1, L_1: E3B [2H2L] → E4A [2H2L]
  - For H_1 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)\left(25\phi^2-6\theta^4-6\theta^2\right)^2}{\left(625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2\right)^2}$$
  - For L_1 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(5\phi-2\theta^2-4\right)^2}{\left(125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(5\phi-2\theta^2-2\right)^2}{\left(625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2\right)^2}$$
- Adding an edge between nodes L_1, L_2: E3B [2H2L] → E4D [2H2L]
  - For L_1 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(5\phi-2\theta^2-4\right)^2}{\left(125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4\right)^2}$$
  - For L_2 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2-12\theta^2\right)^2}{\left(625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4\right)^2}$$
- Removing an edge between nodes H_1, L_2: E3B [2H2L] → E2A [2H2L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4\right)^2}$$

– For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4\right)^2}$$

- Removing an edge between nodes H_1, H_2: E3B [2H2L] → E2C [2H2L]
  – For H_1 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}$$
  – For H_2 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}$$

C.2.13 Stability conditions for: E3C [2H2L]

- Adding an edge between nodes H_1, L_1: E3C [2H2L] → E4A [2H2L]
  – For H_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-15\phi\theta^2-40\phi+6\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)\left(25\phi^2-6\theta^4-6\theta^2\right)^2}{\left(625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2\right)^2}$$
  – For L_1 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2-15\phi\theta^2-40\phi+6\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2\right)^2}$$
- Adding an edge between nodes L_1, L_2: E3C [2H2L] → E4E [2H2L]
  – For L_1 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2-15\phi\theta^2-40\phi+6\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-40\phi\theta^2-40\phi+12\theta^2\right)^2}$$
  – For L_2 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2-15\phi\theta^2-40\phi+6\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-40\phi\theta^2-40\phi+12\theta^2\right)^2}$$
- Removing an edge between nodes H_1, L_2: E3C [2H2L] → E2A [2H2L]
  – For H_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-15\phi\theta^2-40\phi+6\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4\right)^2}$$
  – For L_2 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2-15\phi\theta^2-40\phi+6\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(125\phi^3-75\phi^2\theta^2-125\phi^2+45\phi\theta^2+18\theta^2\right)^2}{\left(3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4\right)^2}$$
- Removing an edge between nodes H_1, H_2: E3C [2H2L] → E2D [2H2L]
  – For H_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-15\phi\theta^2-40\phi+6\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)}{\left(25\phi-3\theta^2-3\right)^2}$$
  – For H_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-15\phi\theta^2-40\phi+6\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)}{\left(25\phi-3\theta^2-3\right)^2}$$

C.2.14 Stability conditions for: E3D [2H2L]

- Adding an edge between nodes H_1, H_2: E3D [2H2L] → E4A [2H2L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)\left(125\phi^3-75\phi^2\theta^2-50\phi^2+12\theta^4\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2\right)^2}$$

  - For H_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)\left(25\phi^2-15\phi-6\theta^4\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)\left(25\phi^2-6\theta^4-6\theta^2\right)^2}{\left(625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2\right)^2}$$

- Adding an edge between nodes H_1, L_1: E3D [2H2L] → E4B [2H2L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)\left(125\phi^3-75\phi^2\theta^2-50\phi^2+12\theta^4\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2+10\phi\theta^2+10\phi-12\theta^2\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(125\phi^3-50\phi^2\theta^2-75\phi^2+12\theta^2\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2+10\phi\theta^2+10\phi-12\theta^2\right)^2}$$

- Adding an edge between nodes L_1, L_2: E3D [2H2L] → E4F [2H2L]
  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(125\phi^3-50\phi^2\theta^2-75\phi^2+12\theta^2\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi\theta^2-6\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2-6\theta^2-6\right)^2}{\left(625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2\right)^2}$$

- Removing an edge between nodes H_1, L_2: E3D [2H2L] → E2B [2H2L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)\left(125\phi^3-75\phi^2\theta^2-50\phi^2+12\theta^4\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\right)\left(25\phi^2-15\phi\theta^2-10\phi-6\theta^2\right)^2}{\left(625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi\theta^2-6\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2\right)^2}$$

- Removing an edge between nodes H_2, L_1: E3D [2H2L] → E2C [2H2L]
  - For H_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)\left(25\phi^2-15\phi-6\theta^4\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(125\phi^3-50\phi^2\theta^2-75\phi^2+12\theta^2\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(25\phi^2-10\phi\theta^2-15\phi-6\theta^2\right)^2}{\left(625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}$$

- Removing an edge between nodes H_2, L_2: E3D [2H2L] → E2D [2H2L]
  - For H_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)\left(25\phi^2-15\phi-6\theta^4\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)}{\left(25\phi-3\theta^2-3\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi\theta^2-6\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(25\phi-3\theta^2-3\right)^2}$$

C.2.15 Stability conditions for: E3E [2H2L]

- Adding an edge between nodes H_2, L_1: E3E [2H2L] → E4C [2H2L]
  - For H_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)\left(25\phi^2-15\phi\theta^2-6\theta^2\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)\left(25\phi^2-12\theta^2\right)^2}{\left(625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(125\phi^3-125\phi^2+12\theta^2\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2\right)^2}$$

- Adding an edge between nodes H_1, L_2: E3E [2H2L] → E4D [2H2L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)\left(125\phi^3-125\phi^2\theta^2+12\theta^4\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi-6\theta^2\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2-12\theta^2\right)^2}{\left(625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4\right)^2}$$

- Adding an edge between nodes H_1, L_1: E3E [2H2L] → E4E [2H2L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)\left(125\phi^3-125\phi^2\theta^2+12\theta^4\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-40\phi\theta^2-40\phi+12\theta^2\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(125\phi^3-125\phi^2+12\theta^2\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-40\phi\theta^2-40\phi+12\theta^2\right)^2}$$

- Removing an edge between nodes L_1, L_2: E3E [2H2L] → E2A [2H2L]
  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(125\phi^3-125\phi^2+12\theta^2\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(125\phi^3-75\phi^2\theta^2-125\phi^2+45\phi\theta^2+18\theta^2\right)^2}{\left(3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi-6\theta^2\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4\right)^2}$$

- Removing an edge between nodes H_2, L_2: E3E [2H2L] → E2E [2H2L]

– For H_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot(25\phi-4)\left(25\phi^2-15\phi\theta^2-6\theta^2\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\theta^2\right)^2\cdot(25\phi-9)}{\left(125\phi^2-90\phi\theta^2-90\phi+36\theta^2\right)^2}$$

– For L_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi-6\theta^2\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2(5\phi-6)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2-90\phi\theta^2-90\phi+36\theta^2\right)^2}$$

- Removing an edge between nodes H_1, H_2: E3E [2H2L] → E2F [2H2L]
  – For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot(25\phi-9)\left(125\phi^3-125\phi^2\theta^2+12\theta^4\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot(25\phi-16)\left(125\phi^3-125\phi^2\theta^2-75\phi^2+45\phi\theta^2+18\theta^4\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4\right)^2}$$

  – For H_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot(25\phi-4)\left(25\phi^2-15\phi\theta^2-6\theta^2\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2(5\phi-4)^2\left(5\phi-3\theta^2\right)^2\cdot(25\phi-9)}{\left(3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4\right)^2}$$

C.2.16 Stability conditions for: E3F [2H2L]

- Adding an edge between nodes H_1, H_2: E3F [2H2L] → E4C [2H2L]
  – For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot(25\phi-16)\left(5\phi-4\theta^2-2\right)^2}{\left(125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot(25\phi-9)}{\left(625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2\right)^2}$$

  – For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2(5\phi-4)^2\cdot(25\phi-4)}{\left(125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot(25\phi-1)\left(25\phi^2-12\theta^2\right)^2}{\left(625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2\right)^2}$$

- Adding an edge between nodes H_1, L_1: E3F [2H2L] → E4F [2H2L]
  – For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot(25\phi-16)\left(5\phi-4\theta^2-2\right)^2}{\left(125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot(25\phi-9)\left(5\phi-2\theta^2-2\right)^2}{\left(625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2\right)^2}$$

  – For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2(5\phi-4)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2-6\theta^2-6\right)^2}{\left(625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2\right)^2}$$

- Removing an edge between nodes L_1, L_2: E3F [2H2L] → E2B [2H2L]
  – For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2(5\phi-4)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2(5\phi-4)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2\right)^2}$$

  – For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2(5\phi-4)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2(5\phi-4)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2\right)^2}$$

- Removing an edge between nodes H_2, L_1: E3F [2H2L] → E2F [2H2L]
  – For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2(5\phi-4)^2\cdot(25\phi-4)}{\left(125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2(5\phi-4)^2\left(5\phi-3\theta^2\right)^2\cdot(25\phi-9)}{\left(3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4\right)^2}$$

– For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4\right)^2}$$

C.2.17 Stability conditions for: E3G [2H2L]

- Adding an edge between nodes H_1, H_2: E3G [2H2L] → E4D [2H2L]
  - For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4\right)^2}$$

  - For H_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4\right)^2}$$

- Adding an edge between nodes H_1, L_1: E3G [2H2L] → E4F [2H2L]
  - For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2\right)^2}$$

- Removing an edge between nodes L_1, L_2: E3G [2H2L] → E2C [2H2L]
  - For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(25\phi^2-10\phi\theta^2-15\phi-6\theta^2\right)^2}{\left(625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2+15\phi-18\theta^2\right)^2}{\left(625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+3\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}$$

- Removing an edge between nodes H_1, L_2: E3G [2H2L] → E2F [2H2L]
  - For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\right)\left(125\phi^3-125\phi^2\theta^2-75\phi^2+45\phi\theta^2+18\theta^4\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2+15\phi-18\theta^2\right)^2}{\left(625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-3\theta\right)^2\left(5\phi+3\theta\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4\right)^2}$$

C.2.18 Stability conditions for: E3H [2H2L]

- Adding an edge between nodes H_1, H_2: E3H [2H2L] → E4E [2H2L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-40\phi\theta^2-15\phi+6\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-40\phi\theta^2-40\phi+12\theta^2\right)^2}$$

  - For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-40\phi\theta^2-15\phi+6\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-40\phi\theta^2-40\phi+12\theta^2\right)^2}$$

- Adding an edge between nodes H_1, L_1: E3H [2H2L] → E4F [2H2L]
  - For H_1 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-40\phi\theta^2-15\phi+6\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2\right)^2}$$
  - For L_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-40\phi\theta^2-15\phi+6\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2-6\theta^2-6\right)^2}{\left(625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2\right)^2}$$
- Removing an edge between nodes L_1, L_2: E3H [2H2L] → E2D [2H2L]
  - For L_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-40\phi\theta^2-15\phi+6\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(25\phi-3\theta^2-3\right)^2}$$
  - For L_2 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-40\phi\theta^2-15\phi+6\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(25\phi-3\theta^2-3\right)^2}$$
- Removing an edge between nodes H_1, L_2: E3H [2H2L] → E2F [2H2L]
  - For H_1 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-40\phi\theta^2-15\phi+6\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\right)\left(125\phi^3-125\phi^2\theta^2-75\phi^2+45\phi\theta^2+18\theta^4\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4\right)^2}$$
  - For L_2 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-40\phi\theta^2-15\phi+6\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4\right)^2}$$

C.2.19 Stability conditions for: E4A [2H2L]

- Adding an edge between nodes H_1, L_1: E4A [2H2L] → E5A [2H2L]
  - For H_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\theta^2\right)^2\cdot\left(25\phi-1\right)}{\left(125\phi^2+10\phi\theta^2-10\phi-4\theta^2\right)^2}$$
  - For L_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(5\phi-2\theta^2-2\right)^2}{\left(625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2+10\phi\theta^2-10\phi-4\theta^2\right)^2}$$
- Adding an edge between nodes L_1, L_2: E4A [2H2L] → E5B [2H2L]
  - For L_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(5\phi-2\theta^2-2\right)^2}{\left(625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-4\theta^2\right)^2\left(5\phi-\theta^2-1\right)^2}$$
  - For L_2 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-\theta^2\right)}{\left(125\phi^2-4\theta^2\right)^2\left(5\phi-\theta^2-1\right)^2}$$
- Removing an edge between nodes H_1, L_2: E4A [2H2L] → E3A [2H2L]
  - For H_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2\right)^2}$$

– For L_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2\right)^2}$$

- Removing an edge between nodes H_2, L_1: E4A [2H2L] → E3B [2H2L]
  – For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)\left(25\phi^2-6\theta^4-6\theta^2\right)^2}{\left(625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2\right)^2}$$

  – For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(5\phi-2\theta^2-2\right)^2}{\left(625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(5\phi-2\theta^2-4\right)^2}{\left(125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2\right)^2}$$

- Removing an edge between nodes H_2, L_2: E4A [2H2L] → E3C [2H2L]
  – For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)\left(25\phi^2-6\theta^4-6\theta^2\right)^2}{\left(625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-15\phi\theta^2-40\phi+6\theta^2\right)^2}$$

  – For L_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2-15\phi\theta^2-40\phi+6\theta^2\right)^2}$$

- Removing an edge between nodes H_1, H_2: E4A [2H2L] → E3D [2H2L]
  – For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)\left(125\phi^3-75\phi^2\theta^2-50\phi^2+12\theta^4\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}$$

  – For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)\left(25\phi^2-6\theta^4-6\theta^2\right)^2}{\left(625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)\left(25\phi^2-15\phi-6\theta^4\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}$$

C.2.20 Stability conditions for: E4B [2H2L]

- Adding an edge between nodes H_1, H_2: E4B [2H2L] → E5A [2H2L]
  – For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2+10\phi\theta^2+10\phi-12\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\theta^2\right)^2\cdot\left(25\phi-1\right)}{\left(125\phi^2+10\phi\theta^2-10\phi-4\theta^2\right)^2}$$

  – For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2+10\phi\theta^2+10\phi-12\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\theta^2\right)^2\cdot\left(25\phi-1\right)}{\left(125\phi^2+10\phi\theta^2-10\phi-4\theta^2\right)^2}$$

- Adding an edge between nodes L_1, L_2: E4B [2H2L] → E5C [2H2L]
  – For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2+10\phi\theta^2+10\phi-12\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\right)^2\cdot\left(25\phi-\theta^2\right)}{\left(125\phi^2-10\phi\theta^2+10\phi-4\theta^2\right)^2}$$

  – For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2+10\phi\theta^2+10\phi-12\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\right)^2\cdot\left(25\phi-\theta^2\right)}{\left(125\phi^2-10\phi\theta^2+10\phi-4\theta^2\right)^2}$$

- Removing an edge between nodes H_1, L_1: E4B [2H2L] → E3D [2H2L]

– For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2+10\phi\theta^2+10\phi-12\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)\left(125\phi^3-75\phi^2\theta^2-50\phi^2+12\theta^4\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}$$

– For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2+10\phi\theta^2+10\phi-12\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(125\phi^3-50\phi^2\theta^2-75\phi^2+12\theta^2\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}$$

C.2.21 Stability conditions for: E4C [2H2L]

- Adding an edge between nodes H_1, L_1: E4C [2H2L] → E5B [2H2L]
  – For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-4\theta^2\right)^2\left(5\phi-\theta^2-1\right)^2}$$

  – For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-\theta^2\right)}{\left(125\phi^2-4\theta^2\right)^2\left(5\phi-\theta^2-1\right)^2}$$

- Removing an edge between nodes L_1, L_2: E4C [2H2L] → E3A [2H2L]
  – For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2\right)^2}$$

  – For L_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2\right)^2}$$

- Removing an edge between nodes H_2, L_1: E4C [2H2L] → E3E [2H2L]
  – For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)\left(25\phi^2-12\theta^2\right)^2}{\left(625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)\left(25\phi^2-15\phi\theta^2-6\theta^2\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}$$

  – For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(125\phi^3-125\phi^2+12\theta^2\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}$$

- Removing an edge between nodes H_1, H_2: E4C [2H2L] → E3F [2H2L]
  – For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\right)\left(5\phi-4\theta^2-2\right)^2}{\left(125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8\right)^2}$$

  – For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)\left(25\phi^2-12\theta^2\right)^2}{\left(625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8\right)^2}$$

C.2.22 Stability conditions for: E4D [2H2L]

- Adding an edge between nodes H_1, L_1: E4D [2H2L] → E5B [2H2L]
  – For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-1\right)}{\left(125\phi^2-4\theta^2\right)^2\left(5\phi-\theta^2-1\right)^2}$$

– For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-4\theta^2\right)^2\left(5\phi-\theta^2-1\right)^2}$$

- Removing an edge between nodes L_1, L_2: E4D [2H2L] → E3B [2H2L]
  – For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\theta^2\right)\left(5\phi-2\theta^2-4\right)^2}{\left(125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2\right)^2}$$

  – For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2-12\theta^2\right)^2}{\left(625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2\right)^2}$$

- Removing an edge between nodes H_1, L_2: E4D [2H2L] → E3E [2H2L]
  – For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)\left(125\phi^3-125\phi^2\theta^2+12\theta^4\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}$$

  – For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2-12\theta^2\right)^2}{\left(625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi-6\theta^2\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}$$

- Removing an edge between nodes H_1, H_2: E4D [2H2L] → E3G [2H2L]
  – For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4\right)^2}$$

  – For H_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4\right)^2}$$

C.2.23 Stability conditions for: E4E [2H2L]

- Adding an edge between nodes H_1, L_1: E4E [2H2L] → E5B [2H2L]
  – For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-40\phi\theta^2-40\phi+12\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-1\right)}{\left(125\phi^2-4\theta^2\right)^2\left(5\phi-\theta^2-1\right)^2}$$

  – For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-40\phi\theta^2-40\phi+12\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-\theta^2\right)}{\left(125\phi^2-4\theta^2\right)^2\left(5\phi-\theta^2-1\right)^2}$$

- Removing an edge between nodes L_1, L_2: E4E [2H2L] → E3C [2H2L]
  – For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-40\phi\theta^2-40\phi+12\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2-15\phi\theta^2-40\phi+6\theta^2\right)^2}$$

  – For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-40\phi\theta^2-40\phi+12\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2-15\phi\theta^2-40\phi+6\theta^2\right)^2}$$

- Removing an edge between nodes H_1, L_2: E4E [2H2L] → E3E [2H2L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-40\phi\theta^2-40\phi+12\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)\left(125\phi^3-125\phi^2\theta^2+12\theta^4\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-40\phi\theta^2-40\phi+12\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(125\phi^3-125\phi^2+12\theta^2\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}$$

- Removing an edge between nodes H_1, H_2: E4E [2H2L] → E3H [2H2L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-40\phi\theta^2-40\phi+12\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-40\phi\theta^2-15\phi+6\theta^2\right)^2}$$

  - For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-40\phi\theta^2-40\phi+12\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-40\phi\theta^2-15\phi+6\theta^2\right)^2}$$

C.2.24 Stability conditions for: E4F [2H2L]

- Adding an edge between nodes H_1, H_2: E4F [2H2L] → E5B [2H2L]
  - For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)\left(5\phi-2\theta^2-2\right)^2}{\left(625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-4\theta^2\right)^2\left(5\phi-\theta^2-1\right)^2}$$

  - For H_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-1\right)}{\left(125\phi^2-4\theta^2\right)^2\left(5\phi-\theta^2-1\right)^2}$$

- Adding an edge between nodes H_1, L_1: E4F [2H2L] → E5C [2H2L]
  - For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)\left(5\phi-2\theta^2-2\right)^2}{\left(625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-10\phi\theta^2+10\phi-4\theta^2\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\right)^2\cdot\left(25\phi-\theta^2\right)}{\left(125\phi^2-10\phi\theta^2+10\phi-4\theta^2\right)^2}$$

- Removing an edge between nodes L_1, L_2: E4F [2H2L] → E3D [2H2L]
  - For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(125\phi^3-50\phi^2\theta^2-75\phi^2+12\theta^2\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2-6\theta^2-6\right)^2}{\left(625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi\theta^2-6\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}$$

- Removing an edge between nodes H_1, L_2: E4F [2H2L] → E3F [2H2L]
  - For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)\left(5\phi-2\theta^2-2\right)^2}{\left(625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\right)\left(5\phi-4\theta^2-2\right)^2}{\left(125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2-6\theta^2-6\right)^2}{\left(625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8\right)^2}$$

- Removing an edge between nodes H_2, L_1: E4F [2H2L] → E3G [2H2L]
  - For H_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4\right)^2}$$

- Removing an edge between nodes H_2, L_2: E4F [2H2L] → E3H [2H2L]
  - For H_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-40\phi\theta^2-15\phi+6\theta^2\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2-6\theta^2-6\right)^2}{\left(625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-40\phi\theta^2-15\phi+6\theta^2\right)^2}$$

C.2.25 Stability conditions for: E5A [2H2L]

- Adding an edge between nodes L_1, L_2: E5A [2H2L] → E6A [2H2L]
  - For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2+10\phi\theta^2-10\phi-4\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)}{\left(25\phi-2\theta^2-2\right)^2}$$

  - For L_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2+10\phi\theta^2-10\phi-4\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)}{\left(25\phi-2\theta^2-2\right)^2}$$

- Removing an edge between nodes H_1, L_1: E5A [2H2L] → E4A [2H2L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\theta^2\right)^2\cdot\left(25\phi-1\right)}{\left(125\phi^2+10\phi\theta^2-10\phi-4\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2+10\phi\theta^2-10\phi-4\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(5\phi-2\theta^2-2\right)^2}{\left(625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2\right)^2}$$

- Removing an edge between nodes H_1, H_2: E5A [2H2L] → E4B [2H2L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\theta^2\right)^2\cdot\left(25\phi-1\right)}{\left(125\phi^2+10\phi\theta^2-10\phi-4\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2+10\phi\theta^2+10\phi-12\theta^2\right)^2}$$

  - For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\theta^2\right)^2\cdot\left(25\phi-1\right)}{\left(125\phi^2+10\phi\theta^2-10\phi-4\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2+10\phi\theta^2+10\phi-12\theta^2\right)^2}$$

C.2.26 Stability conditions for: E5B [2H2L]

- Adding an edge between nodes H_1, L_1: E5B [2H2L] → E6A [2H2L]
  - For H_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-4\theta^2\right)^2\left(5\phi-\theta^2-1\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)}{\left(25\phi-2\theta^2-2\right)^2}$$
  - For L_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-4\theta^2\right)^2\left(5\phi-\theta^2-1\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)}{\left(25\phi-2\theta^2-2\right)^2}$$
- Removing an edge between nodes L_1, L_2: E5B [2H2L] → E4A [2H2L]
  - For L_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-4\theta^2\right)^2\left(5\phi-\theta^2-1\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\theta^2\right)\left(5\phi-2\theta^2-2\right)^2}{\left(625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2\right)^2}$$
  - For L_2 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-\theta^2\right)}{\left(125\phi^2-4\theta^2\right)^2\left(5\phi-\theta^2-1\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2\right)^2}$$
- Removing an edge between nodes H_1, L_2: E5B [2H2L] → E4C [2H2L]
  - For H_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-4\theta^2\right)^2\left(5\phi-\theta^2-1\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2\right)^2}$$
  - For L_2 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-\theta^2\right)}{\left(125\phi^2-4\theta^2\right)^2\left(5\phi-\theta^2-1\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2\right)^2}$$
- Removing an edge between nodes H_2, L_1: E5B [2H2L] → E4D [2H2L]
  - For H_2 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-1\right)}{\left(125\phi^2-4\theta^2\right)^2\left(5\phi-\theta^2-1\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4\right)^2}$$
  - For L_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-4\theta^2\right)^2\left(5\phi-\theta^2-1\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4\right)^2}$$
- Removing an edge between nodes H_2, L_2: E5B [2H2L] → E4E [2H2L]
  - For H_2 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-1\right)}{\left(125\phi^2-4\theta^2\right)^2\left(5\phi-\theta^2-1\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-40\phi\theta^2-40\phi+12\theta^2\right)^2}$$
  - For L_2 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-\theta^2\right)}{\left(125\phi^2-4\theta^2\right)^2\left(5\phi-\theta^2-1\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-40\phi\theta^2-40\phi+12\theta^2\right)^2}$$
- Removing an edge between nodes H_1, H_2: E5B [2H2L] → E4F [2H2L]
  - For H_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-4\theta^2\right)^2\left(5\phi-\theta^2-1\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)\left(5\phi-2\theta^2-2\right)^2}{\left(625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2\right)^2}$$
  - For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^{2}\left(5\phi-2\theta\right)^{2}\left(5\phi+2\theta\right)^{2}\cdot\left(25\phi-1\right)}{\left(125\phi^{2}-4\theta^{2}\right)^{2}\left(5\phi-\theta^{2}-1\right)^{2}}\geq\frac{25\phi^{3}\left(\alpha-\bar{c}\right)^{2}\left(5\phi-3\right)^{2}\cdot\left(25\phi-4\right)}{\left(625\phi^{3}-125\phi^{2}\theta^{2}-325\phi^{2}+6\theta^{4}+6\theta^{2}\right)^{2}}$$

C.2.27 Stability conditions for: E5C [2H2L]

- Adding an edge between nodes H_1, H_2: E5C [2H2L] → E6A [2H2L]
  - For H_1 not to be profitable:
$$\frac{25\phi^{3}\left(\alpha-\bar{c}\right)^{2}\cdot\left(25\phi-4\right)}{\left(125\phi^{2}-10\phi\theta^{2}+10\phi-4\theta^{2}\right)^{2}}>\frac{\phi\left(\alpha-\bar{c}\right)^{2}\cdot\left(25\phi-1\right)}{\left(25\phi-2\theta^{2}-2\right)^{2}}$$
  - For H_2 not to be profitable:
$$\frac{25\phi^{3}\left(\alpha-\bar{c}\right)^{2}\cdot\left(25\phi-4\right)}{\left(125\phi^{2}-10\phi\theta^{2}+10\phi-4\theta^{2}\right)^{2}}>\frac{\phi\left(\alpha-\bar{c}\right)^{2}\cdot\left(25\phi-1\right)}{\left(25\phi-2\theta^{2}-2\right)^{2}}$$
- Removing an edge between nodes L_1, L_2: E5C [2H2L] → E4B [2H2L]
  - For L_1 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^{2}\left(5\phi+2\right)^{2}\cdot\left(25\phi-\theta^{2}\right)}{\left(125\phi^{2}-10\phi\theta^{2}+10\phi-4\theta^{2}\right)^{2}}\geq\frac{\phi\left(\alpha-\bar{c}\right)^{2}\left(5\phi+2\right)^{2}\cdot\left(25\phi-4\theta^{2}\right)}{\left(125\phi^{2}+10\phi\theta^{2}+10\phi-12\theta^{2}\right)^{2}}$$
  - For L_2 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^{2}\left(5\phi+2\right)^{2}\cdot\left(25\phi-\theta^{2}\right)}{\left(125\phi^{2}-10\phi\theta^{2}+10\phi-4\theta^{2}\right)^{2}}\geq\frac{\phi\left(\alpha-\bar{c}\right)^{2}\left(5\phi+2\right)^{2}\cdot\left(25\phi-4\theta^{2}\right)}{\left(125\phi^{2}+10\phi\theta^{2}+10\phi-12\theta^{2}\right)^{2}}$$
- Removing an edge between nodes H_1, L_1: E5C [2H2L] → E4F [2H2L]
  - For H_1 not to be profitable:
$$\frac{25\phi^{3}\left(\alpha-\bar{c}\right)^{2}\cdot\left(25\phi-4\right)}{\left(125\phi^{2}-10\phi\theta^{2}+10\phi-4\theta^{2}\right)^{2}}\geq\frac{25\phi^{3}\left(\alpha-\bar{c}\right)^{2}\cdot\left(25\phi-9\right)\left(5\phi-2\theta^{2}-2\right)^{2}}{\left(625\phi^{3}-125\phi^{2}\theta^{2}-325\phi^{2}+6\theta^{4}+6\theta^{2}\right)^{2}}$$
  - For L_1 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^{2}\left(5\phi+2\right)^{2}\cdot\left(25\phi-\theta^{2}\right)}{\left(125\phi^{2}-10\phi\theta^{2}+10\phi-4\theta^{2}\right)^{2}}\geq\frac{25\phi^{3}\left(\alpha-\bar{c}\right)^{2}\left(5\phi-3\right)^{2}\cdot\left(25\phi-4\theta^{2}\right)}{\left(625\phi^{3}-125\phi^{2}\theta^{2}-325\phi^{2}+6\theta^{4}+6\theta^{2}\right)^{2}}$$

C.2.28 Stability conditions for: E6A [2H2L]

- Removing an edge between nodes L_1, L_2: E6A [2H2L] → E5A [2H2L]
  - For L_1 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^{2}\cdot\left(25\phi-\theta^{2}\right)}{\left(25\phi-2\theta^{2}-2\right)^{2}}\geq\frac{25\phi^{3}\left(\alpha-\bar{c}\right)^{2}\cdot\left(25\phi-4\theta^{2}\right)}{\left(125\phi^{2}+10\phi\theta^{2}-10\phi-4\theta^{2}\right)^{2}}$$
  - For L_2 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^{2}\cdot\left(25\phi-\theta^{2}\right)}{\left(25\phi-2\theta^{2}-2\right)^{2}}\geq\frac{25\phi^{3}\left(\alpha-\bar{c}\right)^{2}\cdot\left(25\phi-4\theta^{2}\right)}{\left(125\phi^{2}+10\phi\theta^{2}-10\phi-4\theta^{2}\right)^{2}}$$
- Removing an edge between nodes H_1, L_1: E6A [2H2L] → E5B [2H2L]
  - For H_1 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^{2}\cdot\left(25\phi-1\right)}{\left(25\phi-2\theta^{2}-2\right)^{2}}\geq\frac{25\phi^{3}\left(\alpha-\bar{c}\right)^{2}\left(5\phi-2\theta^{2}\right)^{2}\cdot\left(25\phi-4\right)}{\left(125\phi^{2}-4\theta^{2}\right)^{2}\left(5\phi-\theta^{2}-1\right)^{2}}$$
  - For L_1 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^{2}\cdot\left(25\phi-\theta^{2}\right)}{\left(25\phi-2\theta^{2}-2\right)^{2}}\geq\frac{25\phi^{3}\left(\alpha-\bar{c}\right)^{2}\left(5\phi-2\right)^{2}\cdot\left(25\phi-4\theta^{2}\right)}{\left(125\phi^{2}-4\theta^{2}\right)^{2}\left(5\phi-\theta^{2}-1\right)^{2}}$$
- Removing an edge between nodes H_1, H_2: E6A [2H2L] → E5C [2H2L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^{2}\cdot\left(25\phi-1\right)}{\left(25\phi-2\theta^{2}-2\right)^{2}}\geq\frac{25\phi^{3}\left(\alpha-\bar{c}\right)^{2}\cdot\left(25\phi-4\right)}{\left(125\phi^{2}-10\phi\theta^{2}+10\phi-4\theta^{2}\right)^{2}}$$

– For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^{2}\cdot\left(25\phi-1\right)}{\left(25\phi-2\theta^{2}-2\right)^{2}}\geq\frac{25\phi^{3}\left(\alpha-\bar{c}\right)^{2}\cdot\left(25\phi-4\right)}{\left(125\phi^{2}-10\phi\theta^{2}+10\phi-4\theta^{2}\right)^{2}}$$

C.3 Three *high*- and one *low*-productive firms ($3H1L$)

C.3.1 Stability conditions for: E0A [3H1L]

- Adding an edge between nodes H_1, H_2: E0A [3H1L] → E1A [3H1L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-16\right)}{\left(125\phi^2-80\phi\theta^2-40\phi+16\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-400\phi^2\theta^2-850\phi^2+480\phi\theta^2+240\phi-96\theta^2\right)^2}$$

  - For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-16\right)}{\left(125\phi^2-80\phi\theta^2-40\phi+16\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-400\phi^2\theta^2-850\phi^2+480\phi\theta^2+240\phi-96\theta^2\right)^2}$$

- Adding an edge between nodes H_1, L_1: E0A [3H1L] → E1B [3H1L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-16\right)}{\left(125\phi^2-80\phi\theta^2-40\phi+16\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-45\phi\theta^2-105\phi+12\theta^2+12\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-16\theta^2\right)}{\left(125\phi^2-80\phi\theta^2-40\phi+16\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2-45\phi\theta^2-105\phi+12\theta^2+12\right)^2}$$

C.3.2 Stability conditions for: E1A [3H1L]

- Adding an edge between nodes H_1, H_2: E1A [3H1L] → E2A [3H1L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-16\right)}{\left(625\phi^3-400\phi^2\theta^2-850\phi^2+480\phi\theta^2+240\phi-96\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(5\phi+1\right)^2\left(125\phi^2-80\phi\theta^2-60\phi+24\theta^2\right)^2}$$

  - For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-400\phi^2\theta^2-850\phi^2+480\phi\theta^2+240\phi-96\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+3\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(5\phi+1\right)^2\left(125\phi^2-80\phi\theta^2-60\phi+24\theta^2\right)^2}$$

- Adding an edge between nodes H_2, L_1: E1A [3H1L] → E2B [3H1L]
  - For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-400\phi^2\theta^2-850\phi^2+480\phi\theta^2+240\phi-96\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-3\theta\right)^2\left(5\phi+3\theta\right)^2\cdot\left(25\phi-4\right)}{\left(3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-16\theta^2\right)}{\left(625\phi^3-400\phi^2\theta^2-850\phi^2+480\phi\theta^2+240\phi-96\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2\right)^2}$$

- Adding an edge between nodes H_1, L_1: E1A [3H1L] → E2C [3H1L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-16\right)}{\left(625\phi^3-400\phi^2\theta^2-850\phi^2+480\phi\theta^2+240\phi-96\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-45\phi\theta^2-135\phi+18\theta^2+18\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-16\theta^2\right)}{\left(625\phi^3-400\phi^2\theta^2-850\phi^2+480\phi\theta^2+240\phi-96\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2-45\phi\theta^2-135\phi+18\theta^2+18\right)^2}$$

- Removing an edge between nodes H_2, H_3: E1A [3H1L] → E0A [3H1L]
  - For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^{2}\left(5\phi-4\right)^{2}\left(5\phi-4\theta^{2}\right)^{2}\cdot\left(25\phi-9\right)}{\left(625\phi^{3}-400\phi^{2}\theta^{2}-850\phi^{2}+480\phi\theta^{2}+240\phi-96\theta^{2}\right)^{2}}\geq\frac{\phi\left(\alpha-\bar{c}\right)^{2}\left(5\phi-4\theta^{2}\right)^{2}\cdot\left(25\phi-16\right)}{\left(125\phi^{2}-80\phi\theta^{2}-40\phi+16\theta^{2}\right)^{2}}$$

– For H_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^{2}\left(5\phi-4\right)^{2}\left(5\phi-4\theta^{2}\right)^{2}\cdot\left(25\phi-9\right)}{\left(625\phi^{3}-400\phi^{2}\theta^{2}-850\phi^{2}+480\phi\theta^{2}+240\phi-96\theta^{2}\right)^{2}}\geq\frac{\phi\left(\alpha-\bar{c}\right)^{2}\left(5\phi-4\theta^{2}\right)^{2}\cdot\left(25\phi-16\right)}{\left(125\phi^{2}-80\phi\theta^{2}-40\phi+16\theta^{2}\right)^{2}}$$

C.3.3 Stability conditions for: E1B [3H1L]

- Adding an edge between nodes H_1, H_3: E1B [3H1L] → E2B [3H1L]
  – For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^{2}\cdot\left(25\phi-16\right)\left(5\phi-3\theta^{2}-3\right)^{2}}{\left(125\phi^{2}-45\phi\theta^{2}-105\phi+12\theta^{2}+12\right)^{2}}>\frac{25\phi^{3}\left(\alpha-\bar{c}\right)^{2}\left(5\phi-4\right)^{2}\left(5\phi-3\theta^{2}\right)^{2}\cdot\left(25\phi-9\right)}{\left(3125\phi^{4}-1125\phi^{3}\theta^{2}-3625\phi^{3}+825\phi^{2}\theta^{2}+800\phi^{2}+180\phi\theta^{2}-72\theta^{2}\right)^{2}}$$

  – For H_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^{2}\left(5\phi-4\right)^{2}\cdot\left(25\phi-9\right)}{\left(125\phi^{2}-45\phi\theta^{2}-105\phi+12\theta^{2}+12\right)^{2}}>\frac{\phi\left(\alpha-\bar{c}\right)^{2}\left(5\phi-4\right)^{2}\left(5\phi-3\theta\right)^{2}\left(5\phi+3\theta\right)^{2}\cdot\left(25\phi-4\right)}{\left(3125\phi^{4}-1125\phi^{3}\theta^{2}-3625\phi^{3}+825\phi^{2}\theta^{2}+800\phi^{2}+180\phi\theta^{2}-72\theta^{2}\right)^{2}}$$

- Adding an edge between nodes H_1, H_2: E1B [3H1L] → E2C [3H1L]
  – For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^{2}\cdot\left(25\phi-16\right)\left(5\phi-3\theta^{2}-3\right)^{2}}{\left(125\phi^{2}-45\phi\theta^{2}-105\phi+12\theta^{2}+12\right)^{2}}>\frac{\phi\left(\alpha-\bar{c}\right)^{2}\cdot\left(25\phi-9\right)\left(5\phi-3\theta^{2}-3\right)^{2}}{\left(125\phi^{2}-45\phi\theta^{2}-135\phi+18\theta^{2}+18\right)^{2}}$$

  – For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^{2}\cdot\left(25\phi-16\right)\left(5\phi-3\theta^{2}-3\right)^{2}}{\left(125\phi^{2}-45\phi\theta^{2}-105\phi+12\theta^{2}+12\right)^{2}}>\frac{\phi\left(\alpha-\bar{c}\right)^{2}\cdot\left(25\phi-9\right)\left(5\phi-3\theta^{2}-3\right)^{2}}{\left(125\phi^{2}-45\phi\theta^{2}-135\phi+18\theta^{2}+18\right)^{2}}$$

- Adding an edge between nodes H_1, L_1: E1B [3H1L] → E2D [3H1L]
  – For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^{2}\cdot\left(25\phi-16\right)\left(5\phi-3\theta^{2}-3\right)^{2}}{\left(125\phi^{2}-45\phi\theta^{2}-105\phi+12\theta^{2}+12\right)^{2}}>\frac{25\phi^{3}\left(\alpha-\bar{c}\right)^{2}\left(5\phi-4\right)^{2}\cdot\left(25\phi-9\right)}{\left(625\phi^{3}-100\phi^{2}\theta^{2}-475\phi^{2}-20\phi\theta^{2}+24\theta^{2}\right)^{2}}$$

  – For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^{2}\left(5\phi-4\right)^{2}\cdot\left(25\phi-9\theta^{2}\right)}{\left(125\phi^{2}-45\phi\theta^{2}-105\phi+12\theta^{2}+12\right)^{2}}>\frac{\phi\left(\alpha-\bar{c}\right)^{2}\left(5\phi-4\right)^{2}\left(5\phi+3\right)^{2}\cdot\left(25\phi-4\theta^{2}\right)}{\left(625\phi^{3}-100\phi^{2}\theta^{2}-475\phi^{2}-20\phi\theta^{2}+24\theta^{2}\right)^{2}}$$

- Removing an edge between nodes H_3, L_1: E1B [3H1L] → E0A [3H1L]
  – For H_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^{2}\left(5\phi-4\right)^{2}\cdot\left(25\phi-9\right)}{\left(125\phi^{2}-45\phi\theta^{2}-105\phi+12\theta^{2}+12\right)^{2}}\geq\frac{\phi\left(\alpha-\bar{c}\right)^{2}\left(5\phi-4\theta^{2}\right)^{2}\cdot\left(25\phi-16\right)}{\left(125\phi^{2}-80\phi\theta^{2}-40\phi+16\theta^{2}\right)^{2}}$$

  – For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^{2}\left(5\phi-4\right)^{2}\cdot\left(25\phi-9\theta^{2}\right)}{\left(125\phi^{2}-45\phi\theta^{2}-105\phi+12\theta^{2}+12\right)^{2}}\geq\frac{\phi\left(\alpha-\bar{c}\right)^{2}\left(5\phi-4\right)^{2}\cdot\left(25\phi-16\theta^{2}\right)}{\left(125\phi^{2}-80\phi\theta^{2}-40\phi+16\theta^{2}\right)^{2}}$$

C.3.4 Stability conditions for: E2A [3H1L]

- Adding an edge between nodes H_3, L_1: E2A [3H1L] → E3A [3H1L]
  – For H_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^{2}\left(5\phi+3\right)^{2}\left(5\phi-4\theta^{2}\right)^{2}\cdot\left(25\phi-4\right)}{\left(5\phi+1\right)^{2}\left(125\phi^{2}-80\phi\theta^{2}-60\phi+24\theta^{2}\right)^{2}}>\frac{\phi\left(\alpha-\bar{c}\right)^{2}\cdot\left(25\phi-1\right)\left(25\phi^{2}+15\phi-18\theta^{2}\right)^{2}}{\left(625\phi^{3}-225\phi^{2}\theta^{2}-100\phi^{2}-45\phi\theta^{2}-15\phi+18\theta^{2}\right)^{2}}$$

  – For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\right)^2\cdot\left(25\phi-16\theta^2\right)}{\left(125\phi^2-80\phi\theta^2-60\phi+24\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2\right)^2}$$

- Adding an edge between nodes H_1, H_2: E2A [3H1L] → E3B [3H1L]
  - For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(5\phi+1\right)^2\left(125\phi^2-80\phi\theta^2-60\phi+24\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-80\phi\theta^2-60\phi+24\theta^2\right)^2}$$

  - For H_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(5\phi+1\right)^2\left(125\phi^2-80\phi\theta^2-60\phi+24\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-80\phi\theta^2-60\phi+24\theta^2\right)^2}$$

- Adding an edge between nodes H_1, L_1: E2A [3H1L] → E3C [3H1L]
  - For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(5\phi+1\right)^2\left(125\phi^2-80\phi\theta^2-60\phi+24\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)\left(25\phi^2-15\phi-6\theta^2\right)^2}{\left(3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\right)^2\cdot\left(25\phi-16\theta^2\right)}{\left(125\phi^2-80\phi\theta^2-60\phi+24\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-9\theta^2\right)\left(25\phi^2-15\phi-6\right)^2}{\left(3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2\right)^2}$$

- Removing an edge between nodes H_1, H_3: E2A [3H1L] → E1A [3H1L]
  - For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(5\phi+1\right)^2\left(125\phi^2-80\phi\theta^2-60\phi+24\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-16\right)}{\left(625\phi^3-400\phi^2\theta^2-850\phi^2+480\phi\theta^2+240\phi-96\theta^2\right)^2}$$

  - For H_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+3\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(5\phi+1\right)^2\left(125\phi^2-80\phi\theta^2-60\phi+24\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-400\phi^2\theta^2-850\phi^2+480\phi\theta^2+240\phi-96\theta^2\right)^2}$$

C.3.5 Stability conditions for: E2B [3H1L]

- Adding an edge between nodes H_1, H_3: E2B [3H1L] → E3A [3H1L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\right)\left(125\phi^3-75\phi^2\theta^2-125\phi^2+45\phi\theta^2+18\theta^2\right)^2}{\left(3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2\right)^2}$$

  - For H_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-3\theta\right)^2\left(5\phi+3\theta\right)^2\cdot\left(25\phi-4\right)}{\left(3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)\left(25\phi^2+15\phi-18\theta^2\right)^2}{\left(625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2\right)^2}$$

- Adding an edge between nodes H_1, H_2: E2B [3H1L] → E3C [3H1L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\right)\left(125\phi^3-75\phi^2\theta^2-125\phi^2+45\phi\theta^2+18\theta^2\right)^2}{\left(3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-9\right)\left(25\phi^2-15\phi\theta^2-6\theta^2\right)^2}{\left(3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2\right)^2}$$

  - For H_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)\left(25\phi^2-15\phi\theta^2-6\right)^2}{\left(3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2\right)^2}$$

- Adding an edge between nodes H_2, L_1: E2B [3H1L] → E3D [3H1L]

– For H_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16\right)^2}$$

– For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16\right)^2}$$

- Adding an edge between nodes H_1, L_1: E2B [3H1L] → E3E [3H1L]
  – For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\right)\left(125\phi^3-75\phi^2\theta^2-125\phi^2+45\phi\theta^2+18\theta^2\right)^2}{\left(3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)\left(125\phi^3-125\phi^2+12\theta^2\right)^2}{\left(3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2\right)^2}$$

  – For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi-6\right)^2}{\left(3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2\right)^2}$$

- Removing an edge between nodes H_3, L_1: E2B [3H1L] → E1A [3H1L]
  – For H_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-3\theta\right)^2\left(5\phi+3\theta\right)^2\cdot\left(25\phi-4\right)}{\left(3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-400\phi^2\theta^2-850\phi^2+480\phi\theta^2+240\phi-96\theta^2\right)^2}$$

  – For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-16\theta^2\right)}{\left(625\phi^3-400\phi^2\theta^2-850\phi^2+480\phi\theta^2+240\phi-96\theta^2\right)^2}$$

- Removing an edge between nodes H_2, H_3: E2B [3H1L] → E1B [3H1L]
  – For H_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\right)\left(5\phi-3\theta^2-3\right)^2}{\left(125\phi^2-45\phi\theta^2-105\phi+12\theta^2+12\right)^2}$$

  – For H_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-3\theta\right)^2\left(5\phi+3\theta\right)^2\cdot\left(25\phi-4\right)}{\left(3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-45\phi\theta^2-105\phi+12\theta^2+12\right)^2}$$

C.3.6 Stability conditions for: E2C [3H1L]

- Adding an edge between nodes H_1, H_2: E2C [3H1L] → E3C [3H1L]
  – For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-45\phi\theta^2-135\phi+18\theta^2+18\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)\left(25\phi^2-15\phi-6\theta^2\right)^2}{\left(3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2\right)^2}$$

  – For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)\left(5\phi-3\theta^2-3\right)^2}{\left(125\phi^2-45\phi\theta^2-135\phi+18\theta^2+18\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)\left(25\phi^2-15\phi\theta^2-6\right)^2}{\left(3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2\right)^2}$$

- Adding an edge between nodes H_2, L_1: E2C [3H1L] → E3E [3H1L]
  – For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot(25\phi-9)\left(5\phi-3\theta^2-3\right)^2}{\left(125\phi^2-45\phi\theta^2-135\phi+18\theta^2+18\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot(25\phi-4)\left(25\phi^2-15\phi-6\theta^2\right)^2}{\left(3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2-45\phi\theta^2-135\phi+18\theta^2+18\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi-6\right)^2}{\left(3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2\right)^2}$$

- Removing an edge between nodes H_1, L_1: E2C [3H1L] → E1A [3H1L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\right)^2\cdot(25\phi-9)}{\left(125\phi^2-45\phi\theta^2-135\phi+18\theta^2+18\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\right)^2\left(5\phi-4\theta^2\right)^2\cdot(25\phi-16)}{\left(625\phi^3-400\phi^2\theta^2-850\phi^2+480\phi\theta^2+240\phi-96\theta^2\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2-45\phi\theta^2-135\phi+18\theta^2+18\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-16\theta^2\right)}{\left(625\phi^3-400\phi^2\theta^2-850\phi^2+480\phi\theta^2+240\phi-96\theta^2\right)^2}$$

- Removing an edge between nodes H_2, H_3: E2C [3H1L] → E1B [3H1L]
  - For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot(25\phi-9)\left(5\phi-3\theta^2-3\right)^2}{\left(125\phi^2-45\phi\theta^2-135\phi+18\theta^2+18\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot(25\phi-16)\left(5\phi-3\theta^2-3\right)^2}{\left(125\phi^2-45\phi\theta^2-105\phi+12\theta^2+12\right)^2}$$

  - For H_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot(25\phi-9)\left(5\phi-3\theta^2-3\right)^2}{\left(125\phi^2-45\phi\theta^2-135\phi+18\theta^2+18\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot(25\phi-16)\left(5\phi-3\theta^2-3\right)^2}{\left(125\phi^2-45\phi\theta^2-105\phi+12\theta^2+12\right)^2}$$

C.3.7 Stability conditions for: E2D [3H1L]

- Adding an edge between nodes H_2, H_3: E2D [3H1L] → E3D [3H1L]
  - For H_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot(25\phi-9)}{\left(625\phi^3-100\phi^2\theta^2-475\phi^2-20\phi\theta^2+24\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot(25\phi-4)}{\left(125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16\right)^2}$$

  - For H_3 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot(25\phi-9)}{\left(625\phi^3-100\phi^2\theta^2-475\phi^2-20\phi\theta^2+24\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot(25\phi-4)}{\left(125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16\right)^2}$$

- Adding an edge between nodes H_1, H_2: E2D [3H1L] → E3E [3H1L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot(25\phi-16)\left(25\phi^2-10\phi\theta^2-15\phi-6\theta^2\right)^2}{\left(625\phi^3-100\phi^2\theta^2-475\phi^2-20\phi\theta^2+24\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot(25\phi-9)\left(125\phi^3-50\phi^2\theta^2-75\phi^2+12\theta^2\right)^2}{\left(3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2\right)^2}$$

  - For H_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot(25\phi-9)}{\left(625\phi^3-100\phi^2\theta^2-475\phi^2-20\phi\theta^2+24\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot(25\phi-4)\left(25\phi^2-15\phi-6\theta^2\right)^2}{\left(3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2\right)^2}$$

- Adding an edge between nodes H_1, L_1: E2D [3H1L] → E3F [3H1L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot(25\phi-16)\left(25\phi^2-10\phi\theta^2-15\phi-6\theta^2\right)^2}{\left(625\phi^3-100\phi^2\theta^2-475\phi^2-20\phi\theta^2+24\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot(25\phi-9)}{\left(125\phi^2-5\phi\theta^2+15\phi-6\theta^2\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi+3\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-100\phi^2\theta^2-475\phi^2-20\phi\theta^2+24\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+6\right)^2\cdot\left(25\phi-\theta^2\right)}{\left(125\phi^2-5\phi\theta^2+15\phi-6\theta^2\right)^2}$$

- Removing an edge between nodes H_2, L_1: E2D [3H1L] → E1B [3H1L]
  - For H_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-100\phi^2\theta^2-475\phi^2-20\phi\theta^2+24\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\right)\left(5\phi-3\theta^2-3\right)^2}{\left(125\phi^2-45\phi\theta^2-105\phi+12\theta^2+12\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi+3\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-100\phi^2\theta^2-475\phi^2-20\phi\theta^2+24\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2-45\phi\theta^2-105\phi+12\theta^2+12\right)^2}$$

C.3.8 Stability conditions for: E3A [3H1L]

- Adding an edge between nodes H_1, H_2: E3A [3H1L] → E4A [3H1L]
  - For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2\right)^2}$$

  - For H_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2\right)^2}$$

- Adding an edge between nodes H_1, L_1: E3A [3H1L] → E4B [3H1L]
  - For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6\right)^2}$$

- Removing an edge between nodes H_3, L_1: E3A [3H1L] → E2A [3H1L]
  - For H_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)\left(25\phi^2+15\phi-18\theta^2\right)^2}{\left(625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+3\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(5\phi+1\right)^2\left(125\phi^2-80\phi\theta^2-60\phi+24\theta^2\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\right)^2\cdot\left(25\phi-16\theta^2\right)}{\left(125\phi^2-80\phi\theta^2-60\phi+24\theta^2\right)^2}$$

- Removing an edge between nodes H_1, H_3: E3A [3H1L] → E2B [3H1L]
  - For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\right)\left(125\phi^3-75\phi^2\theta^2-125\phi^2+45\phi\theta^2+18\theta^2\right)^2}{\left(3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2\right)^2}$$

  - For H_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)\left(25\phi^2+15\phi-18\theta^2\right)^2}{\left(625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-3\theta\right)^2\left(5\phi+3\theta\right)^2\cdot\left(25\phi-4\right)}{\left(3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2\right)^2}$$

C.3.9 Stability conditions for: E3B [3H1L]

- Adding an edge between nodes H_1, L_1: E3B [3H1L] → E4A [3H1L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-80\phi\theta^2-60\phi+24\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)\left(25\phi^2-12\theta^2\right)^2}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\right)^2\cdot\left(25\phi-16\theta^2\right)}{\left(125\phi^2-80\phi\theta^2-60\phi+24\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2\right)^2}$$

- Removing an edge between nodes H_1, H_2: E3B [3H1L] → E2A [3H1L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-80\phi\theta^2-60\phi+24\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(5\phi+1\right)^2\left(125\phi^2-80\phi\theta^2-60\phi+24\theta^2\right)^2}$$

  - For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-80\phi\theta^2-60\phi+24\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(5\phi+1\right)^2\left(125\phi^2-80\phi\theta^2-60\phi+24\theta^2\right)^2}$$

C.3.10 Stability conditions for: E3C [3H1L]

- Adding an edge between nodes H_1, H_2: E3C [3H1L] → E4A [3H1L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-9\right)\left(25\phi^2-15\phi\theta^2-6\theta^2\right)^2}{\left(3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2\right)^2}$$

  - For H_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)\left(25\phi^2-15\phi-6\theta^2\right)^2}{\left(3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)\left(25\phi^2-12\theta^2\right)^2}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2\right)^2}$$

- Adding an edge between nodes H_3, L_1: E3C [3H1L] → E4B [3H1L]
  - For H_3 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)\left(25\phi^2-15\phi\theta^2-6\right)^2}{\left(3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)\left(25\phi^2-6\theta^2-6\right)^2}{\left(625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-9\theta^2\right)\left(25\phi^2-15\phi-6\right)^2}{\left(3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6\right)^2}$$

- Adding an edge between nodes H_1, L_1: E3C [3H1L] → E4C [3H1L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-9\right)\left(25\phi^2-15\phi\theta^2-6\theta^2\right)^2}{\left(3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-100\phi^2\theta^2-50\phi^2-60\phi\theta^2-40\phi+24\theta^2\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-9\theta^2\right)\left(25\phi^2-15\phi-6\right)^2}{\left(3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\left(5\phi+2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-100\phi^2\theta^2-50\phi^2-60\phi\theta^2-40\phi+24\theta^2\right)^2}$$

- Removing an edge between nodes H_2, L_1: E3C [3H1L] → E2A [3H1L]
  - For H_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)\left(25\phi^2-15\phi-6\theta^2\right)^2}{\left(3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(5\phi+1\right)^2\left(125\phi^2-80\phi\theta^2-60\phi+24\theta^2\right)^2}$$

– For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-9\theta^2\right)\left(25\phi^2-15\phi-6\right)^2}{\left(3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\right)^2\cdot\left(25\phi-16\theta^2\right)}{\left(125\phi^2-80\phi\theta^2-60\phi+24\theta^2\right)^2}$$

- Removing an edge between nodes H_1, H_3: E3C [3H1L] → E2B [3H1L]
  – For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-9\right)\left(25\phi^2-15\phi\theta^2-6\theta^2\right)^2}{\left(3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\right)\left(125\phi^3-75\phi^2\theta^2-125\phi^2+45\phi\theta^2+18\theta^2\right)^2}{\left(3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2\right)^2}$$

  – For H_3 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)\left(25\phi^2-15\phi\theta^2-6\right)^2}{\left(3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2\right)^2}$$

- Removing an edge between nodes H_2, H_3: E3C [3H1L] → E2C [3H1L]
  – For H_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)\left(25\phi^2-15\phi-6\theta^2\right)^2}{\left(3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-45\phi\theta^2-135\phi+18\theta^2+18\right)^2}$$

  – For H_3 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)\left(25\phi^2-15\phi\theta^2-6\right)^2}{\left(3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)\left(5\phi-3\theta^2-3\right)^2}{\left(125\phi^2-45\phi\theta^2-135\phi+18\theta^2+18\right)^2}$$

C.3.11 Stability conditions for: E3D [3H1L]

- Adding an edge between nodes H_1, H_2: E3D [3H1L] → E4B [3H1L]
  – For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\right)\left(5\phi-2\theta^2-4\right)^2}{\left(125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)\left(5\phi-2\theta^2-2\right)^2}{\left(625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6\right)^2}$$

  – For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)\left(25\phi^2-6\theta^2-6\right)^2}{\left(625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6\right)^2}$$

- Adding an edge between nodes H_1, L_1: E3D [3H1L] → E4D [3H1L]
  – For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\right)\left(5\phi-2\theta^2-4\right)^2}{\left(125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2\right)^2}$$

  – For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2-12\right)^2}{\left(625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2\right)^2}$$

- Removing an edge between nodes H_2, L_1: E3D [3H1L] → E2B [3H1L]
  – For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2\right)^2}$$

  – For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2\right)^2}$$

- Removing an edge between nodes H_2, H_3: E3D [3H1L] → E2D [3H1L]
  - For H_2 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-100\phi^2\theta^2-475\phi^2-20\phi\theta^2+24\theta^2\right)^2}$$
  - For H_3 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-100\phi^2\theta^2-475\phi^2-20\phi\theta^2+24\theta^2\right)^2}$$

C.3.12 Stability conditions for: E3E [3H1L]

- Adding an edge between nodes H_1, H_3: E3E [3H1L] → E4B [3H1L]
  - For H_1 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)\left(125\phi^3-125\phi^2+12\theta^2\right)^2}{\left(3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6\right)^2}$$
  - For H_3 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)\left(25\phi^2-15\phi-6\theta^2\right)^2}{\left(3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)\left(25\phi^2-6\theta^2-6\right)^2}{\left(625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6\right)^2}$$
- Adding an edge between nodes H_1, H_2: E3E [3H1L] → E4C [3H1L]
  - For H_1 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)\left(125\phi^3-125\phi^2+12\theta^2\right)^2}{\left(3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-100\phi^2\theta^2-50\phi^2-60\phi\theta^2-40\phi+24\theta^2\right)^2}$$
  - For H_2 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)\left(125\phi^3-50\phi^2\theta^2-75\phi^2+12\theta^2\right)^2}{\left(3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-100\phi^2\theta^2-50\phi^2-60\phi\theta^2-40\phi+24\theta^2\right)^2}$$
- Adding an edge between nodes H_2, L_1: E3E [3H1L] → E4D [3H1L]
  - For H_2 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)\left(125\phi^3-50\phi^2\theta^2-75\phi^2+12\theta^2\right)^2}{\left(3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2\right)^2}$$
  - For L_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi-6\right)^2}{\left(3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2-12\right)^2}{\left(625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2\right)^2}$$
- Removing an edge between nodes H_1, L_1: E3E [3H1L] → E2B [3H1L]
  - For H_1 not to be profitable:
$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)\left(125\phi^3-125\phi^2+12\theta^2\right)^2}{\left(3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\right)\left(125\phi^3-75\phi^2\theta^2-125\phi^2+45\phi\theta^2+18\theta^2\right)^2}{\left(3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2\right)^2}$$
  - For L_1 not to be profitable:
$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi-6\right)^2}{\left(3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2\right)^2}$$
- Removing an edge between nodes H_3, L_1: E3E [3H1L] → E2C [3H1L]

- For H_3 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)\left(25\phi^2-15\phi-6\theta^2\right)^2}{\left(3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)\left(5\phi-3\theta^2-3\right)^2}{\left(125\phi^2-45\phi\theta^2-135\phi+18\theta^2+18\right)^2}$$

- For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi-6\right)^2}{\left(3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(125\phi^2-45\phi\theta^2-135\phi+18\theta^2+18\right)^2}$$

- Removing an edge between nodes H_2, H_3: E3E [3H1L] → E2D [3H1L]
  - For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)\left(125\phi^3-50\phi^2\theta^2-75\phi^2+12\theta^2\right)^2}{\left(3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\right)\left(25\phi^2-10\phi\theta^2-15\phi-6\theta^2\right)^2}{\left(625\phi^3-100\phi^2\theta^2-475\phi^2-20\phi\theta^2+24\theta^2\right)^2}$$

  - For H_3 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)\left(25\phi^2-15\phi-6\theta^2\right)^2}{\left(3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-100\phi^2\theta^2-475\phi^2-20\phi\theta^2+24\theta^2\right)^2}$$

C.3.13 Stability conditions for: E3F [3H1L]

- Adding an edge between nodes H_1, H_2: E3F [3H1L] → E4D [3H1L]
  - For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-5\phi\theta^2+15\phi-6\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2\right)^2}$$

  - For H_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-5\phi\theta^2+15\phi-6\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2\right)^2}$$

- Removing an edge between nodes H_1, L_1: E3F [3H1L] → E2D [3H1L]
  - For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-5\phi\theta^2+15\phi-6\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\right)\left(25\phi^2-10\phi\theta^2-15\phi-6\theta^2\right)^2}{\left(625\phi^3-100\phi^2\theta^2-475\phi^2-20\phi\theta^2+24\theta^2\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+6\right)^2\cdot\left(25\phi-\theta^2\right)}{\left(125\phi^2-5\phi\theta^2+15\phi-6\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\left(5\phi+3\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-100\phi^2\theta^2-475\phi^2-20\phi\theta^2+24\theta^2\right)^2}$$

C.3.14 Stability conditions for: E4A [3H1L]

- Adding an edge between nodes H_1, L_1: E4A [3H1L] → E5A [3H1L]
  - For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-1\right)}{\left(625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2\right)^2}$$

- Removing an edge between nodes H_1, H_2: E4A [3H1L] → E3A [3H1L]
  - For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2\right)^2}$$

– For H_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2\right)^2}$$

- Removing an edge between nodes H_3, L_1: E4A [3H1L] → E3B [3H1L]
  – For H_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)\left(25\phi^2-12\theta^2\right)^2}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-80\phi\theta^2-60\phi+24\theta^2\right)^2}$$

  – For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-6\right)^2\cdot\left(25\phi-16\theta^2\right)}{\left(125\phi^2-80\phi\theta^2-60\phi+24\theta^2\right)^2}$$

- Removing an edge between nodes H_1, H_3: E4A [3H1L] → E3C [3H1L]
  – For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-9\right)\left(25\phi^2-15\phi\theta^2-6\theta^2\right)^2}{\left(3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2\right)^2}$$

  – For H_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)\left(25\phi^2-12\theta^2\right)^2}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)\left(25\phi^2-15\phi-6\theta^2\right)^2}{\left(3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2\right)^2}$$

C.3.15 Stability conditions for: E4B [3H1L]

- Adding an edge between nodes H_1, H_2: E4B [3H1L] → E5A [3H1L]
  – For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)\left(5\phi-2\theta^2-2\right)^2}{\left(625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2\right)^2}$$

  – For H_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-1\right)}{\left(625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2\right)^2}$$

- Adding an edge between nodes H_1, L_1: E4B [3H1L] → E5B [3H1L]
  – For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)\left(5\phi-2\theta^2-2\right)^2}{\left(625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2\right)^2}$$

  – For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\right)^2\cdot\left(25\phi-\theta^2\right)}{\left(125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2\right)^2}$$

- Removing an edge between nodes H_2, L_1: E4B [3H1L] → E3A [3H1L]
  – For H_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2\right)^2}$$

  – For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2\right)^2}$$

- Removing an edge between nodes H_3, L_1: E4B [3H1L] → E3C [3H1L]

– For H_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)\left(25\phi^2-6\theta^2-6\right)^2}{\left(625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)\left(25\phi^2-15\phi\theta^2-6\right)^2}{\left(3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2\right)^2}$$

– For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-9\theta^2\right)\left(25\phi^2-15\phi-6\right)^2}{\left(3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2\right)^2}$$

- Removing an edge between nodes H_1, H_3: E4B [3H1L] → E3D [3H1L]
  – For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)\left(5\phi-2\theta^2-2\right)^2}{\left(625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\right)\left(5\phi-2\theta^2-4\right)^2}{\left(125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16\right)^2}$$

  – For H_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)\left(25\phi^2-6\theta^2-6\right)^2}{\left(625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16\right)^2}$$

- Removing an edge between nodes H_2, H_3: E4B [3H1L] → E3E [3H1L]
  – For H_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)\left(125\phi^3-125\phi^2+12\theta^2\right)^2}{\left(3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2\right)^2}$$

  – For H_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)\left(25\phi^2-6\theta^2-6\right)^2}{\left(625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)\left(25\phi^2-15\phi-6\theta^2\right)^2}{\left(3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2\right)^2}$$

C.3.16 Stability conditions for: E4C [3H1L]

- Adding an edge between nodes H_1, H_2: E4C [3H1L] → E5A [3H1L]
  – For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-100\phi^2\theta^2-50\phi^2-60\phi\theta^2-40\phi+24\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-1\right)}{\left(625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2\right)^2}$$

  – For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-100\phi^2\theta^2-50\phi^2-60\phi\theta^2-40\phi+24\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-1\right)}{\left(625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2\right)^2}$$

- Adding an edge between nodes H_3, L_1: E4C [3H1L] → E5B [3H1L]
  – For H_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-100\phi^2\theta^2-50\phi^2-60\phi\theta^2-40\phi+24\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\right)^2\cdot\left(25\phi-1\right)}{\left(125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2\right)^2}$$

  – For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\left(5\phi+2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-100\phi^2\theta^2-50\phi^2-60\phi\theta^2-40\phi+24\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\right)^2\cdot\left(25\phi-\theta^2\right)}{\left(125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2\right)^2}$$

- Removing an edge between nodes H_1, L_1: E4C [3H1L] → E3C [3H1L]
  – For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-100\phi^2\theta^2-50\phi^2-60\phi\theta^2-40\phi+24\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-9\right)\left(25\phi^2-15\phi\theta^2-6\theta^2\right)^2}{\left(3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2\right)^2}$$

  – For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\left(5\phi+2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-100\phi^2\theta^2-50\phi^2-60\phi\theta^2-40\phi+24\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-9\theta^2\right)\left(25\phi^2-15\phi-6\right)^2}{\left(3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2\right)^2}$$

- Removing an edge between nodes H_1, H_3: E4C [3H1L] → E3E [3H1L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-100\phi^2\theta^2-50\phi^2-60\phi\theta^2-40\phi+24\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)\left(125\phi^3-125\phi^2+12\theta^2\right)^2}{\left(3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2\right)^2}$$

  - For H_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-100\phi^2\theta^2-50\phi^2-60\phi\theta^2-40\phi+24\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)\left(125\phi^3-50\phi^2\theta^2-75\phi^2+12\theta^2\right)^2}{\left(3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2\right)^2}$$

C.3.17 Stability conditions for: E4D [3H1L]

- Adding an edge between nodes H_1, H_2: E4D [3H1L] → E5B [3H1L]
  - For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2\right)^2}>\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2\right)^2}$$

  - For H_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\right)^2\cdot\left(25\phi-1\right)}{\left(125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2\right)^2}$$

- Removing an edge between nodes H_1, L_1: E4D [3H1L] → E3D [3H1L]
  - For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-16\right)\left(5\phi-2\theta^2-4\right)^2}{\left(125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2-12\right)^2}{\left(625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16\right)^2}$$

- Removing an edge between nodes H_2, L_1: E4D [3H1L] → E3E [3H1L]
  - For H_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)\left(125\phi^3-50\phi^2\theta^2-75\phi^2+12\theta^2\right)^2}{\left(3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2-12\right)^2}{\left(625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi-6\right)^2}{\left(3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2\right)^2}$$

- Removing an edge between nodes H_2, H_3: E4D [3H1L] → E3F [3H1L]
  - For H_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-5\phi\theta^2+15\phi-6\theta^2\right)^2}$$

  - For H_3 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)}{\left(125\phi^2-5\phi\theta^2+15\phi-6\theta^2\right)^2}$$

C.3.18 Stability conditions for: E5A [3H1L]

- Adding an edge between nodes H_1, L_1: E5A [3H1L] → E6A [3H1L]
  - For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)}{\left(25\phi-\theta^2-3\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)}{\left(25\phi-\theta^2-3\right)^2}$$

- Removing an edge between nodes H_2, L_1: E5A [3H1L] → E4A [3H1L]
  - For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-1\right)}{\left(625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2\right)^2}$$

- Removing an edge between nodes H_1, H_2: E5A [3H1L] → E4B [3H1L]
  - For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)\left(5\phi-2\theta^2-2\right)^2}{\left(625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6\right)^2}$$

  - For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-1\right)}{\left(625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6\right)^2}$$

- Removing an edge between nodes H_2, H_3: E5A [3H1L] → E4C [3H1L]
  - For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-1\right)}{\left(625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-100\phi^2\theta^2-50\phi^2-60\phi\theta^2-40\phi+24\theta^2\right)^2}$$

  - For H_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-1\right)}{\left(625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta\right)^2\left(5\phi+2\theta\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-100\phi^2\theta^2-50\phi^2-60\phi\theta^2-40\phi+24\theta^2\right)^2}$$

C.3.19 Stability conditions for: E5B [3H1L]

- Adding an edge between nodes H_1, H_2: E5B [3H1L] → E6A [3H1L]
  - For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)}{\left(25\phi-\theta^2-3\right)^2}$$

  - For H_2 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2\right)^2}>\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)}{\left(25\phi-\theta^2-3\right)^2}$$

- Removing an edge between nodes H_1, L_1: E5B [3H1L] → E4B [3H1L]
  - For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-9\right)\left(5\phi-2\theta^2-2\right)^2}{\left(625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6\right)^2}$$

– For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\right)^2\cdot\left(25\phi-\theta^2\right)}{\left(125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6\right)^2}$$

- Removing an edge between nodes H_3, L_1: E5B [3H1L] → E4C [3H1L]
  - For H_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\right)^2\cdot\left(25\phi-1\right)}{\left(125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-100\phi^2\theta^2-50\phi^2-60\phi\theta^2-40\phi+24\theta^2\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\right)^2\cdot\left(25\phi-\theta^2\right)}{\left(125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2\right)^2}\geq\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\left(5\phi+2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-100\phi^2\theta^2-50\phi^2-60\phi\theta^2-40\phi+24\theta^2\right)^2}$$

- Removing an edge between nodes H_1, H_3: E5B [3H1L] → E4D [3H1L]
  - For H_1 not to be profitable:

$$\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-4\right)^2\cdot\left(25\phi-9\right)}{\left(625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2\right)^2}$$

  - For H_3 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\left(5\phi+2\right)^2\cdot\left(25\phi-1\right)}{\left(125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-3\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2\right)^2}$$

C.3.20 Stability conditions for: E6A [3H1L]

- Removing an edge between nodes H_1, L_1: E6A [3H1L] → E5A [3H1L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)}{\left(25\phi-\theta^2-3\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-4\right)}{\left(625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2\right)^2}$$

  - For L_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-\theta^2\right)}{\left(25\phi-\theta^2-3\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\left(5\phi-2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2\right)^2}$$

- Removing an edge between nodes H_1, H_2: E6A [3H1L] → E5B [3H1L]
  - For H_1 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)}{\left(25\phi-\theta^2-3\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2\right)^2}$$

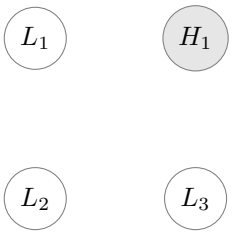
  - For H_2 not to be profitable:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-1\right)}{\left(25\phi-\theta^2-3\right)^2}\geq\frac{25\phi^3\left(\alpha-\bar{c}\right)^2\cdot\left(25\phi-4\right)}{\left(125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2\right)^2}$$

D Solution of four-firm case

D.1 One *high*- and three *low*-productive firms ($1H3L$)

D.1.1 E0A [1H3L]



$$Equations: \begin{cases} e_1^H \cdot \left(\frac{25\phi}{4} - 4\right) = \alpha - e_1^L\theta - e_2^L\theta - e_3^L\theta - \bar{c} \\ e_1^L \cdot \left(\frac{25\phi}{4\theta} - 4\theta\right) = \alpha - e_1^H - e_2^L\theta - e_3^L\theta - \bar{c} \\ e_2^L \cdot \left(\frac{25\phi}{4\theta} - 4\theta\right) = \alpha - e_1^H - e_1^L\theta - e_3^L\theta - \bar{c} \\ e_3^L \cdot \left(\frac{25\phi}{4\theta} - 4\theta\right) = \alpha - e_1^H - e_1^L\theta - e_2^L\theta - \bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{4(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-40\phi\theta^2-80\phi+16\theta^2} \\ e_1^L &= \frac{4\theta(\alpha-\bar{c})(5\phi-4)}{125\phi^2-40\phi\theta^2-80\phi+16\theta^2} \\ e_2^L &= \frac{4\theta(\alpha-\bar{c})(5\phi-4)}{125\phi^2-40\phi\theta^2-80\phi+16\theta^2} \\ e_3^L &= \frac{4\theta(\alpha-\bar{c})(5\phi-4)}{125\phi^2-40\phi\theta^2-80\phi+16\theta^2} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{20\alpha\phi-16\alpha\theta^2-125\bar{c}\phi^2+40\bar{c}\phi\theta^2+60\bar{c}\phi}{125\phi^2-40\phi\theta^2-80\phi+16\theta^2} \\ c_1^L &= -\frac{20\alpha\phi\theta^2-16\alpha\theta^2-125\bar{c}\phi^2+20\bar{c}\phi\theta^2+80\bar{c}\phi}{125\phi^2-40\phi\theta^2-80\phi+16\theta^2} \\ c_2^L &= -\frac{20\alpha\phi\theta^2-16\alpha\theta^2-125\bar{c}\phi^2+20\bar{c}\phi\theta^2+80\bar{c}\phi}{125\phi^2-40\phi\theta^2-80\phi+16\theta^2} \\ c_3^L &= -\frac{20\alpha\phi\theta^2-16\alpha\theta^2-125\bar{c}\phi^2+20\bar{c}\phi\theta^2+80\bar{c}\phi}{125\phi^2-40\phi\theta^2-80\phi+16\theta^2} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-40\phi\theta^2-80\phi+16\theta^2} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-4)}{125\phi^2-40\phi\theta^2-80\phi+16\theta^2} \\ q_2^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-4)}{125\phi^2-40\phi\theta^2-80\phi+16\theta^2} \\ q_3^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-4)}{125\phi^2-40\phi\theta^2-80\phi+16\theta^2} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-4\theta^2\right)^2\cdot(25\phi-16)}{(125\phi^2-40\phi\theta^2-80\phi+16\theta^2)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-4)^2\cdot\left(25\phi-16\theta^2\right)}{(125\phi^2-40\phi\theta^2-80\phi+16\theta^2)^2} \\ \pi_2^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-4)^2\cdot\left(25\phi-16\theta^2\right)}{(125\phi^2-40\phi\theta^2-80\phi+16\theta^2)^2} \\ \pi_3^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-4)^2\cdot\left(25\phi-16\theta^2\right)}{(125\phi^2-40\phi\theta^2-80\phi+16\theta^2)^2} \end{cases} \tag{32}$$

Total Production:

$$\frac{20\phi\left(\alpha-\bar{c}\right)\left(5\phi-\theta^2-3\right)}{125\phi^2-40\phi\theta^2-80\phi+16\theta^2}$$

Price:

$$\frac{25\alpha\phi^2-20\alpha\phi\theta^2-20\alpha\phi+16\alpha\theta^2+100\bar{c}\phi^2-20\bar{c}\phi\theta^2-60\bar{c}\phi}{125\phi^2-40\phi\theta^2-80\phi+16\theta^2}$$

Firm Surplus:

$$\frac{4\phi\left(\alpha-\bar{c}\right)^2\cdot\left(625\phi^3-550\phi^2\theta^2-850\phi^2+100\phi\theta^4+640\phi\theta^2+300\phi-64\theta^4-192\theta^2\right)}{\left(125\phi^2-40\phi\theta^2-80\phi+16\theta^2\right)^2}$$

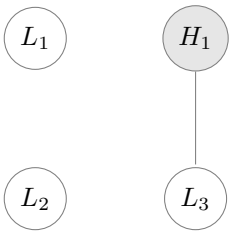
Consumer Surplus:

$$\frac{200\phi^2\left(\alpha-\bar{c}\right)^2\left(5\phi-\theta^2-3\right)^2}{\left(125\phi^2-40\phi\theta^2-80\phi+16\theta^2\right)^2}$$

Social Welfare:

$$\frac{4\phi\left(\alpha-\bar{c}\right)^2\cdot\left(1875\phi^3-1050\phi^2\theta^2-2350\phi^2+150\phi\theta^4+940\phi\theta^2+750\phi-64\theta^4-192\theta^2\right)}{\left(125\phi^2-40\phi\theta^2-80\phi+16\theta^2\right)^2}$$

D.1.2 E1A [1H3L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{3}-3\right)=\alpha-e_1^L\theta-e_2^L\theta+3e_3^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{4\theta}-4\theta\right)=\alpha-2e_1^H-e_2^L\theta-2e_3^L\theta-\bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{4\theta}-4\theta\right)=\alpha-2e_1^H-e_1^L\theta-2e_3^L\theta-\bar{c} \\ e_3^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right)=\alpha+3e_1^H-e_1^L\theta-e_2^L\theta-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{3(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2} \\ e_1^L &= \frac{4\theta(\alpha-\bar{c})\left(5\phi-3\theta^2-3\right)}{125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2} \\ e_2^L &= \frac{4\theta(\alpha-\bar{c})\left(5\phi-3\theta^2-3\right)}{125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2} \\ e_3^L &= \frac{3\theta(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{15\alpha\phi\theta^2+15\alpha\phi-12\alpha\theta^4-12\alpha\theta^2-125\bar{c}\phi^2+90\bar{c}\phi\theta^2+30\bar{c}\phi}{125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2} \\ c_1^L &= -\frac{20\alpha\phi\theta^2-12\alpha\theta^4-12\alpha\theta^2-125\bar{c}\phi^2+85\bar{c}\phi\theta^2+45\bar{c}\phi}{125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2} \\ c_2^L &= -\frac{20\alpha\phi\theta^2-12\alpha\theta^4-12\alpha\theta^2-125\bar{c}\phi^2+85\bar{c}\phi\theta^2+45\bar{c}\phi}{125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2} \\ c_3^L &= -\frac{15\alpha\phi\theta^2+15\alpha\phi-12\alpha\theta^4-12\alpha\theta^2-125\bar{c}\phi^2+90\bar{c}\phi\theta^2+30\bar{c}\phi}{125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-3\theta^2-3\right)}{125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2} \\ q_2^L &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-3\theta^2-3\right)}{125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2} \\ q_3^L &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-4\theta^2\right)^2\cdot(25\phi-9)}{(125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2\cdot\left(25\phi-16\theta^2\right)\left(5\phi-3\theta^2-3\right)^2}{(125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2)^2} \\ \pi_2^L &= \frac{\phi(\alpha-\bar{c})^2\cdot\left(25\phi-16\theta^2\right)\left(5\phi-3\theta^2-3\right)^2}{(125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2)^2} \\ \pi_3^L &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{(125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2)^2} \end{cases} \tag{33}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(10\phi-7\theta^2-3\right)}{125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2}$$

Price:

$$\frac{25\alpha\phi^2-35\alpha\phi\theta^2-15\alpha\phi+12\alpha\theta^4+12\alpha\theta^2+100\bar{c}\phi^2-70\bar{c}\phi\theta^2-30\bar{c}\phi}{125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2}$$

Firm Surplus:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(2500\phi^3-4525\phi^2\theta^2-1725\phi^2+2570\phi\theta^4+2220\phi\theta^2+450\phi-432\theta^6-720\theta^4-288\theta^2\right)}{\left(125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2\right)^2}$$

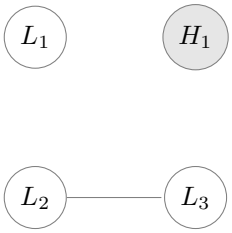
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(10\phi-7\theta^2-3\right)^2}{\left(125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2\right)^2}$$

Social Welfare:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(7500\phi^3-11525\phi^2\theta^2-4725\phi^2+5020\phi\theta^4+4320\phi\theta^2+900\phi-432\theta^6-720\theta^4-288\theta^2\right)}{\left(125\phi^2-105\phi\theta^2-45\phi+12\theta^4+12\theta^2\right)^2}$$

D.1.3 E1B [1H3L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{4}-4\right)=\alpha-e_1^L\theta-2e_2^L\theta-2e_3^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{4\theta}-4\theta\right)=\alpha-e_1^H-2e_2^L\theta-2e_3^L\theta-\bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right)=\alpha-e_1^H-e_1^L\theta+3e_3^L\theta-\bar{c} \\ e_3^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right)=\alpha-e_1^H-e_1^L\theta+3e_2^L\theta-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{4(\alpha-\bar{c})\left(5\phi-6\theta^2\right)\left(5\phi-4\theta^2\right)}{625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4} \\ e_1^L &= \frac{4\theta(\alpha-\bar{c})(5\phi-4)\left(5\phi-6\theta^2\right)}{625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4} \\ e_2^L &= \frac{3\theta(\alpha-\bar{c})(5\phi-4)\left(5\phi-4\theta^2\right)}{625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4} \\ e_3^L &= \frac{3\theta(\alpha-\bar{c})(5\phi-4)\left(5\phi-4\theta^2\right)}{625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{100\alpha\phi^2-200\alpha\phi\theta^2+96\alpha\theta^4-625\bar{c}\phi^3+850\bar{c}\phi^2\theta^2+300\bar{c}\phi^2-240\bar{c}\phi\theta^4-280\bar{c}\phi\theta^2}{625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4} \\ c_1^L &= -\frac{100\alpha\phi^2\theta^2-120\alpha\phi\theta^4-80\alpha\phi\theta^2+96\alpha\theta^4-625\bar{c}\phi^3+750\bar{c}\phi^2\theta^2+400\bar{c}\phi^2-120\bar{c}\phi\theta^4-400\bar{c}\phi\theta^2}{625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4} \\ c_2^L &= -\frac{150\alpha\phi^2\theta^2-120\alpha\phi\theta^4-120\alpha\phi\theta^2+96\alpha\theta^4-625\bar{c}\phi^3+700\bar{c}\phi^2\theta^2+400\bar{c}\phi^2-120\bar{c}\phi\theta^4-360\bar{c}\phi\theta^2}{625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4} \\ c_3^L &= -\frac{150\alpha\phi^2\theta^2-120\alpha\phi\theta^4-120\alpha\phi\theta^2+96\alpha\theta^4-625\bar{c}\phi^3+700\bar{c}\phi^2\theta^2+400\bar{c}\phi^2-120\bar{c}\phi\theta^4-360\bar{c}\phi\theta^2}{625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-6\theta^2\right)\left(5\phi-4\theta^2\right)}{625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-4)\left(5\phi-6\theta^2\right)}{625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4} \\ q_2^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-4)\left(5\phi-4\theta^2\right)}{625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4} \\ q_3^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-4)\left(5\phi-4\theta^2\right)}{625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-6\theta^2\right)^2\left(5\phi-4\theta^2\right)^2\cdot(25\phi-16)}{(625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-4)^2\left(5\phi-6\theta^2\right)^2\cdot\left(25\phi-16\theta^2\right)}{(625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4)^2} \\ \pi_2^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-4)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{(625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4)^2} \\ \pi_3^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-4)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{(625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4)^2} \end{cases} \tag{34}$$

Total Production:

$$\frac{20\phi\left(\alpha-\bar{c}\right)\left(25\phi^2-30\phi\theta^2-15\phi+6\theta^4+14\theta^2\right)}{625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4}$$

Price:

$$\frac{125\alpha\phi^3-250\alpha\phi^2\theta^2-100\alpha\phi^2+120\alpha\phi\theta^4+200\alpha\phi\theta^2-96\alpha\theta^4+500\bar{c}\phi^3-600\bar{c}\phi^2\theta^2-300\bar{c}\phi^2+120\bar{c}\phi\theta^4+280\bar{c}\phi\theta^2}{625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4}$$

Firm Surplus:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(31250\phi^5-85625\phi^4\theta^2-42500\phi^4+88500\phi^3\theta^4+107000\phi^3\theta^2+15000\phi^3-40800\phi^2\theta^6-97200\phi^2\theta^4-34800\phi^2\theta^2+7200\phi\theta^8+36480\phi\theta^6+27040\phi\theta^4-4608\theta^8-6912\theta^6\right)}{\left(625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4\right)^2}$$

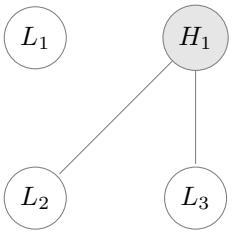
Consumer Surplus:

$$\frac{200\phi^2\left(\alpha-\bar{c}\right)^2\left(25\phi^2-30\phi\theta^2-15\phi+6\theta^4+14\theta^2\right)^2}{\left(625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4\right)^2}$$

Social Welfare:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(93750\phi^5-235625\phi^4\theta^2-117500\phi^4+208500\phi^3\theta^4+267000\phi^3\theta^2+37500\phi^3-76800\phi^2\theta^6-199200\phi^2\theta^4-76800\phi^2\theta^2+10800\phi\theta^8+53280\phi\theta^6+46640\phi\theta^4-4608\theta^8-6912\theta^6\right)}{\left(625\phi^3-850\phi^2\theta^2-400\phi^2+240\phi\theta^4+480\phi\theta^2-96\theta^4\right)^2}$$

D.1.4 E2A [1H3L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{2}-2\right)=\alpha-e_1^L\theta+3e_2^L\theta+3e_3^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{4\theta}-4\theta\right)=\alpha-3e_1^H-2e_2^L\theta-2e_3^L\theta-\bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right)=\alpha+2e_1^H-e_1^L\theta-2e_3^L\theta-\bar{c} \\ e_3^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right)=\alpha+2e_1^H-e_1^L\theta-2e_2^L\theta-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{2(\alpha-\bar{c})\left(5\phi-4\theta^2\right)\left(5\phi+3\theta^2\right)}{625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4} \\ e_1^L &= \frac{4\theta(\alpha-\bar{c})\left(25\phi^2-15\phi\theta^2-10\phi-6\theta^2\right)}{625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4} \\ e_2^L &= \frac{15\phi\theta(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4} \\ e_3^L &= \frac{15\phi\theta(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{150\alpha\phi^2\theta^2+50\alpha\phi^2-120\alpha\phi\theta^4-10\alpha\phi\theta^2-24\alpha\theta^4-625\bar{c}\phi^3+325\bar{c}\phi^2\theta^2+50\bar{c}\phi^2+120\bar{c}\phi\theta^4+30\bar{c}\phi\theta^2}{625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4} \\ c_1^L &= -\frac{100\alpha\phi^2\theta^2-60\alpha\phi\theta^4-40\alpha\phi\theta^2-24\alpha\theta^4-625\bar{c}\phi^3+375\bar{c}\phi^2\theta^2+100\bar{c}\phi^2+60\bar{c}\phi\theta^4+60\bar{c}\phi\theta^2}{625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4} \\ c_2^L &= -\frac{75\alpha\phi^2\theta^2+50\alpha\phi^2-60\alpha\phi\theta^4-10\alpha\phi\theta^2-24\alpha\theta^4-625\bar{c}\phi^3+400\bar{c}\phi^2\theta^2+50\bar{c}\phi^2+60\bar{c}\phi\theta^4+30\bar{c}\phi\theta^2}{625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4} \\ c_3^L &= -\frac{75\alpha\phi^2\theta^2+50\alpha\phi^2-60\alpha\phi\theta^4-10\alpha\phi\theta^2-24\alpha\theta^4-625\bar{c}\phi^3+400\bar{c}\phi^2\theta^2+50\bar{c}\phi^2+60\bar{c}\phi\theta^4+30\bar{c}\phi\theta^2}{625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-4\theta^2\right)\left(5\phi+3\theta^2\right)}{625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})\left(25\phi^2-15\phi\theta^2-10\phi-6\theta^2\right)}{625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4} \\ q_2^L &= \frac{25\phi^2(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4} \\ q_3^L &= \frac{25\phi^2(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-4\theta^2\right)^2\left(5\phi+3\theta^2\right)^2\cdot(25\phi-4)}{(625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2\cdot\left(25\phi-16\theta^2\right)\left(25\phi^2-15\phi\theta^2-10\phi-6\theta^2\right)^2}{(625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4)^2} \\ \pi_2^L &= \frac{25\phi^3(\alpha-\bar{c})^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{(625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4)^2} \\ \pi_3^L &= \frac{25\phi^3(\alpha-\bar{c})^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{(625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4)^2} \end{cases} \tag{35}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(50\phi^2-30\phi\theta^2-5\phi-6\theta^4-3\theta^2\right)}{625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4}$$

Price:

$$\frac{125\alpha\phi^3-175\alpha\phi^2\theta^2-50\alpha\phi^2+60\alpha\phi\theta^4+10\alpha\phi\theta^2+24\alpha\theta^4+500\bar{c}\phi^3-300\bar{c}\phi^2\theta^2-50\bar{c}\phi^2-60\bar{c}\phi\theta^4-30\bar{c}\phi\theta^2}{625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4}$$

Firm Surplus:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(31250\phi^5-48125\phi^4\theta^2-7500\phi^4+20625\phi^3\theta^4+4500\phi^3\theta^2+1250\phi^3-3900\phi^2\theta^6+3400\phi^2\theta^4+700\phi^2\theta^2+1800\phi\theta^8-1680\phi\theta^6-510\phi\theta^4-288\theta^8-288\theta^6\right)}{\left(625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4\right)^2}$$

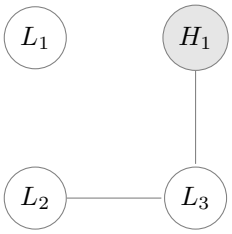
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(50\phi^2-30\phi\theta^2-5\phi-6\theta^4-3\theta^2\right)^2}{\left(625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4\right)^2}$$

Social Welfare:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(93750\phi^5-123125\phi^4\theta^2-20000\phi^4+28125\phi^3\theta^4+4500\phi^3\theta^2+1875\phi^3+5100\phi^2\theta^6+9400\phi^2\theta^4+1450\phi^2\theta^2+2700\phi\theta^8-780\phi\theta^6-285\phi\theta^4-288\theta^8-288\theta^6\right)}{\left(625\phi^3-475\phi^2\theta^2-100\phi^2-20\phi\theta^2+24\theta^4\right)^2}$$

D.1.5 E2B [1H3L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{3}-3\right)=\alpha-e_1^L\theta-2e_2^L\theta+2e_3^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{4\theta}-4\theta\right)=\alpha-2e_1^H-2e_2^L\theta-3e_3^L\theta-\bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right)=\alpha-2e_1^H-e_1^L\theta+2e_3^L\theta-\bar{c} \\ e_3^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right)=\alpha+3e_1^H-e_1^L\theta+3e_2^L\theta-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{15\phi(\alpha-\bar{c})\left(5\phi-4\theta^2\right)\left(5\phi-3\theta^2\right)}{3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6} \\ e_1^L &= \frac{4\theta(\alpha-\bar{c})\left(125\phi^3-125\phi^2\theta^2-75\phi^2+45\phi\theta^2+18\theta^4\right)}{3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6} \\ e_2^L &= \frac{15\phi\theta(\alpha-\bar{c})(5\phi-3)\left(5\phi-4\theta^2\right)}{3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6} \\ e_3^L &= \frac{2\theta(\alpha-\bar{c})(5\phi-3\theta)(5\phi+3\theta)\left(5\phi-4\theta^2\right)}{3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{250\alpha\phi^3\theta^2+375\alpha\phi^3-200\alpha\phi^2\theta^4-525\alpha\phi^2\theta^2+90\alpha\phi\theta^4+72\alpha\theta^6-3125\bar{c}\phi^4+3375\bar{c}\phi^3\theta^2+750\bar{c}\phi^3-600\bar{c}\phi^2\theta^4-300\bar{c}\phi^2\theta^2-270\bar{c}\phi\theta^4}{3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6} \\ c_1^L &= -\frac{500\alpha\phi^3\theta^2-500\alpha\phi^2\theta^4-300\alpha\phi^2\theta^2+180\alpha\phi\theta^4+72\alpha\theta^6-3125\bar{c}\phi^4+3125\bar{c}\phi^3\theta^2+1125\bar{c}\phi^3-300\bar{c}\phi^2\theta^4-525\bar{c}\phi^2\theta^2-360\bar{c}\phi\theta^4}{3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6} \\ c_2^L &= -\frac{625\alpha\phi^3\theta^2-500\alpha\phi^2\theta^4-225\alpha\phi^2\theta^2+90\alpha\phi\theta^4+72\alpha\theta^6-3125\bar{c}\phi^4+3000\bar{c}\phi^3\theta^2+1125\bar{c}\phi^3-300\bar{c}\phi^2\theta^4-600\bar{c}\phi^2\theta^2-270\bar{c}\phi\theta^4}{3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6} \\ c_3^L &= -\frac{625\alpha\phi^3\theta^2+375\alpha\phi^3-500\alpha\phi^2\theta^4-750\alpha\phi^2\theta^2+270\alpha\phi\theta^4+72\alpha\theta^6-3125\bar{c}\phi^4+3000\bar{c}\phi^3\theta^2+750\bar{c}\phi^3-300\bar{c}\phi^2\theta^4-75\bar{c}\phi^2\theta^2-450\bar{c}\phi\theta^4}{3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{25\phi^2(\alpha-\bar{c})\left(5\phi-4\theta^2\right)\left(5\phi-3\theta^2\right)}{3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})\left(125\phi^3-125\phi^2\theta^2-75\phi^2+45\phi\theta^2+18\theta^4\right)}{3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6} \\ q_2^L &= \frac{25\phi^2(\alpha-\bar{c})(5\phi-3)\left(5\phi-4\theta^2\right)}{3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6} \\ q_3^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-3\theta)(5\phi+3\theta)\left(5\phi-4\theta^2\right)}{3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{25\phi^3(\alpha-\bar{c})^2\left(5\phi-4\theta^2\right)^2\left(5\phi-3\theta^2\right)^2\cdot(25\phi-9)}{\left(3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6\right)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2\cdot\left(25\phi-16\theta^2\right)\left(125\phi^3-125\phi^2\theta^2-75\phi^2+45\phi\theta^2+18\theta^4\right)^2}{\left(3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6\right)^2} \\ \pi_2^L &= \frac{25\phi^3(\alpha-\bar{c})^2(5\phi-3)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6\right)^2} \\ \pi_3^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-3\theta)^2(5\phi+3\theta)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6\right)^2} \end{cases} \tag{36}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(250\phi^3-250\phi^2\theta^2-75\phi^2+30\phi\theta^4+30\phi\theta^2+27\theta^4\right)}{3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6}$$

Price:

$$\frac{625\alpha\phi^4-1125\alpha\phi^3\theta^2-375\alpha\phi^3+500\alpha\phi^2\theta^4+525\alpha\phi^2\theta^2-90\alpha\phi\theta^4-72\alpha\theta^6+2500\bar{c}\phi^4-2500\bar{c}\phi^3\theta^2-750\bar{c}\phi^3+300\bar{c}\phi^2\theta^4+300\bar{c}\phi^2\theta^2+270\bar{c}\phi\theta^4}{3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6}$$

Firm Surplus:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(1562500\phi^7-3578125\phi^6\theta^2-1078125\phi^6+2856250\phi^5\theta^4+2081250\phi^5\theta^2+281250\phi^5-905000\phi^4\theta^6-1134375\phi^4\theta^4-534375\phi^4\theta^2+90000\phi^3\theta^8+40500\phi^3\theta^6+312750\phi^3\theta^4+68400\phi^2\theta^8-70200\phi^2\theta^6+27540\phi\theta^8-10368\theta^{10}\right)}{\left(3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6\right)^2}$$

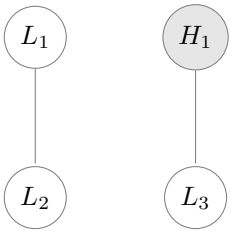
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(250\phi^3-250\phi^2\theta^2-75\phi^2+30\phi\theta^4+30\phi\theta^2+27\theta^4\right)^2}{\left(3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6\right)^2}$$

Social Welfare:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(4687500\phi^7-9828125\phi^6\theta^2-2953125\phi^6+6731250\phi^5\theta^4+4706250\phi^5\theta^2+562500\phi^5-1655000\phi^4\theta^6-1434375\phi^4\theta^4-759375\phi^4\theta^2+135000\phi^3\theta^8-544500\phi^3\theta^6+155250\phi^3\theta^4+149400\phi^2\theta^8+10800\phi^2\theta^6+63990\phi\theta^8-10368\theta^{10}\right)}{\left(3125\phi^4-3625\phi^3\theta^2-1125\phi^3+800\phi^2\theta^4+825\phi^2\theta^2+180\phi\theta^4-72\theta^6\right)^2}$$

D.1.6 E2C [1H3L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{3}-3\right)=\alpha-2e_1^L\theta-2e_2^L\theta+3e_3^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right)=\alpha-2e_1^H+3e_2^L\theta-2e_3^L\theta-\bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right)=\alpha-2e_1^H+3e_1^L\theta-2e_3^L\theta-\bar{c} \\ e_3^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right)=\alpha+3e_1^H-2e_1^L\theta-2e_2^L\theta-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{3(\alpha-\bar{c})\left(5\phi-6\theta^2\right)}{125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2} \\ e_1^L &= \frac{3\theta(\alpha-\bar{c})\left(5\phi-3\theta^2-3\right)}{125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2} \\ e_2^L &= \frac{3\theta(\alpha-\bar{c})\left(5\phi-3\theta^2-3\right)}{125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2} \\ e_3^L &= \frac{3\theta(\alpha-\bar{c})\left(5\phi-6\theta^2\right)}{125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{15\alpha\phi\theta^2+15\alpha\phi-18\alpha\theta^4-18\alpha\theta^2-125\bar{c}\phi^2+120\bar{c}\phi\theta^2+30\bar{c}\phi}{125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2} \\ c_1^L &= -\frac{30\alpha\phi\theta^2-18\alpha\theta^4-18\alpha\theta^2-125\bar{c}\phi^2+105\bar{c}\phi\theta^2+45\bar{c}\phi}{125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2} \\ c_2^L &= -\frac{30\alpha\phi\theta^2-18\alpha\theta^4-18\alpha\theta^2-125\bar{c}\phi^2+105\bar{c}\phi\theta^2+45\bar{c}\phi}{125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2} \\ c_3^L &= -\frac{15\alpha\phi\theta^2+15\alpha\phi-18\alpha\theta^4-18\alpha\theta^2-125\bar{c}\phi^2+120\bar{c}\phi\theta^2+30\bar{c}\phi}{125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-6\theta^2\right)}{125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-3\theta^2-3\right)}{125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2} \\ q_2^L &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-3\theta^2-3\right)}{125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2} \\ q_3^L &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-6\theta^2\right)}{125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-6\theta^2\right)^2\cdot(25\phi-9)}{(125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2\cdot\left(25\phi-9\theta^2\right)\left(5\phi-3\theta^2-3\right)^2}{(125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2)^2} \\ \pi_2^L &= \frac{\phi(\alpha-\bar{c})^2\cdot\left(25\phi-9\theta^2\right)\left(5\phi-3\theta^2-3\right)^2}{(125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2)^2} \\ \pi_3^L &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-6\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{(125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2)^2} \end{cases} \tag{37}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(10\phi-9\theta^2-3\right)}{125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2}$$

Price:

$$\frac{25\alpha\phi^2-45\alpha\phi\theta^2-15\alpha\phi+18\alpha\theta^4+18\alpha\theta^2+100\bar{c}\phi^2-90\bar{c}\phi\theta^2-30\bar{c}\phi}{125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2}$$

Firm Surplus:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(2500\phi^3-5175\phi^2\theta^2-1725\phi^2+3330\phi\theta^4+1980\phi\theta^2+450\phi-486\theta^6-648\theta^4-162\theta^2\right)}{\left(125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2\right)^2}$$

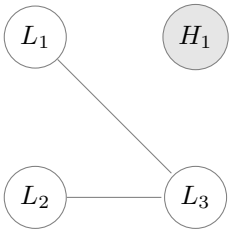
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(10\phi-9\theta^2-3\right)^2}{\left(125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2\right)^2}$$

Social Welfare:

$$\frac{3\phi\left(\alpha-\bar{c}\right)^2\cdot\left(2500\phi^3-4725\phi^2\theta^2-1575\phi^2+2460\phi\theta^4+1560\phi\theta^2+300\phi-162\theta^6-216\theta^4-54\theta^2\right)}{\left(125\phi^2-135\phi\theta^2-45\phi+18\theta^4+18\theta^2\right)^2}$$

D.1.7 E2D [1H3L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{4}-4\right) = \alpha-2e_1^L\theta-2e_2^L\theta-3e_3^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right) = \alpha-e_1^H-2e_2^L\theta+2e_3^L\theta-\bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right) = \alpha-e_1^H-2e_1^L\theta+2e_3^L\theta-\bar{c} \\ e_3^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right) = \alpha-e_1^H+3e_1^L\theta+3e_2^L\theta-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{4(\alpha-\bar{c})\left(5\phi-6\theta^2\right)}{125\phi^2-60\phi\theta^2-80\phi+24\theta^2} \\ e_1^L &= \frac{15\phi\theta(\alpha-\bar{c})(5\phi-4)}{(5\phi+\theta^2)(125\phi^2-60\phi\theta^2-80\phi+24\theta^2)} \\ e_2^L &= \frac{15\phi\theta(\alpha-\bar{c})(5\phi-4)}{(5\phi+\theta^2)(125\phi^2-60\phi\theta^2-80\phi+24\theta^2)} \\ e_3^L &= \frac{2\theta(\alpha-\bar{c})(5\phi-4)\left(5\phi+3\theta^2\right)}{(5\phi+\theta^2)(125\phi^2-60\phi\theta^2-80\phi+24\theta^2)} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{20\alpha\phi-24\alpha\theta^2-125\bar{c}\phi^2+60\bar{c}\phi\theta^2+60\bar{c}\phi}{125\phi^2-60\phi\theta^2-80\phi+24\theta^2} \\ c_1^L &= -\frac{125\alpha\phi^2\theta^2+30\alpha\phi\theta^4-100\alpha\phi\theta^2-24\alpha\theta^4-625\bar{c}\phi^3+50\bar{c}\phi^2\theta^2+400\bar{c}\phi^2+30\bar{c}\phi\theta^4+60\bar{c}\phi\theta^2}{(5\phi+\theta^2)(125\phi^2-60\phi\theta^2-80\phi+24\theta^2)} \\ c_2^L &= -\frac{125\alpha\phi^2\theta^2+30\alpha\phi\theta^4-100\alpha\phi\theta^2-24\alpha\theta^4-625\bar{c}\phi^3+50\bar{c}\phi^2\theta^2+400\bar{c}\phi^2+30\bar{c}\phi\theta^4+60\bar{c}\phi\theta^2}{(5\phi+\theta^2)(125\phi^2-60\phi\theta^2-80\phi+24\theta^2)} \\ c_3^L &= -\frac{200\alpha\phi^2\theta^2+30\alpha\phi\theta^4-160\alpha\phi\theta^2-24\alpha\theta^4-625\bar{c}\phi^3-25\bar{c}\phi^2\theta^2+400\bar{c}\phi^2+30\bar{c}\phi\theta^4+120\bar{c}\phi\theta^2}{(5\phi+\theta^2)(125\phi^2-60\phi\theta^2-80\phi+24\theta^2)} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-6\theta^2\right)}{125\phi^2-60\phi\theta^2-80\phi+24\theta^2} \\ q_1^L &= \frac{25\phi^2(\alpha-\bar{c})(5\phi-4)}{(5\phi+\theta^2)(125\phi^2-60\phi\theta^2-80\phi+24\theta^2)} \\ q_2^L &= \frac{25\phi^2(\alpha-\bar{c})(5\phi-4)}{(5\phi+\theta^2)(125\phi^2-60\phi\theta^2-80\phi+24\theta^2)} \\ q_3^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-4)\left(5\phi+3\theta^2\right)}{(5\phi+\theta^2)(125\phi^2-60\phi\theta^2-80\phi+24\theta^2)} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-6\theta^2\right)^2\cdot(25\phi-16)}{(125\phi^2-60\phi\theta^2-80\phi+24\theta^2)^2} \\ \pi_1^L &= \frac{25\phi^3(\alpha-\bar{c})^2(5\phi-4)^2\cdot\left(25\phi-9\theta^2\right)}{(5\phi+\theta^2)^2(125\phi^2-60\phi\theta^2-80\phi+24\theta^2)^2} \\ \pi_2^L &= \frac{25\phi^3(\alpha-\bar{c})^2(5\phi-4)^2\cdot\left(25\phi-9\theta^2\right)}{(5\phi+\theta^2)^2(125\phi^2-60\phi\theta^2-80\phi+24\theta^2)^2} \\ \pi_3^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-4)^2\left(5\phi+3\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{(5\phi+\theta^2)^2(125\phi^2-60\phi\theta^2-80\phi+24\theta^2)^2} \end{cases} \tag{38}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(10\phi-3\theta^2-6\right)}{125\phi^2-60\phi\theta^2-80\phi+24\theta^2}$$

Price:

$$\frac{25\alpha\phi^2-30\alpha\phi\theta^2-20\alpha\phi+24\alpha\theta^2+100\bar{c}\phi^2-30\bar{c}\phi\theta^2-60\bar{c}\phi}{125\phi^2-60\phi\theta^2-80\phi+24\theta^2}$$

Firm Surplus:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(31250\phi^5-13125\phi^4\theta^2-42500\phi^4+5375\phi^3\theta^4+6000\phi^3\theta^2+15000\phi^3+3300\phi^2\theta^6-4700\phi^2\theta^4+1600\phi^2\theta^2+450\phi\theta^8-1680\phi\theta^6+840\phi\theta^4-288\theta^8-288\theta^6\right)}{\left(5\phi+\theta^2\right)^2\left(125\phi^2-60\phi\theta^2-80\phi+24\theta^2\right)^2}$$

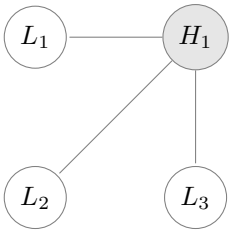
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(10\phi-3\theta^2-6\right)^2}{\left(125\phi^2-60\phi\theta^2-80\phi+24\theta^2\right)^2}$$

Social Welfare:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(93750\phi^5-25625\phi^4\theta^2-117500\phi^4-1500\phi^3\theta^4-1500\phi^3\theta^2+37500\phi^3+4050\phi^2\theta^6+1300\phi^2\theta^4+10600\phi^2\theta^2+675\phi\theta^8-780\phi\theta^6+1740\phi\theta^4-288\theta^8-288\theta^6\right)}{\left(5\phi+\theta^2\right)^2\left(125\phi^2-60\phi\theta^2-80\phi+24\theta^2\right)^2}$$

D.1.8 E3A [1H3L]



$$Equations: \begin{cases} e_1^H\cdot(25\phi-1) = \alpha+3e_1^L\theta+3e_2^L\theta+3e_3^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right) = \alpha+e_1^H-2e_2^L\theta-2e_3^L\theta-\bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right) = \alpha+e_1^H-2e_1^L\theta-2e_3^L\theta-\bar{c} \\ e_3^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right) = \alpha+e_1^H-2e_1^L\theta-2e_2^L\theta-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{(\alpha-\bar{c})\left(5\phi+6\theta^2\right)}{125\phi^2+15\phi\theta^2-5\phi-6\theta^2} \\ e_1^L &= \frac{15\phi\theta(\alpha-\bar{c})}{125\phi^2+15\phi\theta^2-5\phi-6\theta^2} \\ e_2^L &= \frac{15\phi\theta(\alpha-\bar{c})}{125\phi^2+15\phi\theta^2-5\phi-6\theta^2} \\ e_3^L &= \frac{15\phi\theta(\alpha-\bar{c})}{125\phi^2+15\phi\theta^2-5\phi-6\theta^2} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{45\alpha\phi\theta^2+5\alpha\phi+6\alpha\theta^2-125\bar{c}\phi^2-60\bar{c}\phi\theta^2}{125\phi^2+15\phi\theta^2-5\phi-6\theta^2} \\ c_1^L &= -\frac{15\alpha\phi\theta^2+5\alpha\phi+6\alpha\theta^2-125\bar{c}\phi^2-30\bar{c}\phi\theta^2}{125\phi^2+15\phi\theta^2-5\phi-6\theta^2} \\ c_2^L &= -\frac{15\alpha\phi\theta^2+5\alpha\phi+6\alpha\theta^2-125\bar{c}\phi^2-30\bar{c}\phi\theta^2}{125\phi^2+15\phi\theta^2-5\phi-6\theta^2} \\ c_3^L &= -\frac{15\alpha\phi\theta^2+5\alpha\phi+6\alpha\theta^2-125\bar{c}\phi^2-30\bar{c}\phi\theta^2}{125\phi^2+15\phi\theta^2-5\phi-6\theta^2} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi+6\theta^2\right)}{125\phi^2+15\phi\theta^2-5\phi-6\theta^2} \\ q_1^L &= \frac{25\phi^2(\alpha-\bar{c})}{125\phi^2+15\phi\theta^2-5\phi-6\theta^2} \\ q_2^L &= \frac{25\phi^2(\alpha-\bar{c})}{125\phi^2+15\phi\theta^2-5\phi-6\theta^2} \\ q_3^L &= \frac{25\phi^2(\alpha-\bar{c})}{125\phi^2+15\phi\theta^2-5\phi-6\theta^2} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi+6\theta^2\right)^2\cdot(25\phi-1)}{(125\phi^2+15\phi\theta^2-5\phi-6\theta^2)^2} \\ \pi_1^L &= \frac{25\phi^3(\alpha-\bar{c})^2\cdot\left(25\phi-9\theta^2\right)}{(125\phi^2+15\phi\theta^2-5\phi-6\theta^2)^2} \\ \pi_2^L &= \frac{25\phi^3(\alpha-\bar{c})^2\cdot\left(25\phi-9\theta^2\right)}{(125\phi^2+15\phi\theta^2-5\phi-6\theta^2)^2} \\ \pi_3^L &= \frac{25\phi^3(\alpha-\bar{c})^2\cdot\left(25\phi-9\theta^2\right)}{(125\phi^2+15\phi\theta^2-5\phi-6\theta^2)^2} \end{cases} \tag{39}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(10\phi+3\theta^2\right)}{125\phi^2+15\phi\theta^2-5\phi-6\theta^2}$$

Price:

$$\frac{25\alpha\phi^2-15\alpha\phi\theta^2-5\alpha\phi-6\alpha\theta^2+100\bar{c}\phi^2+30\bar{c}\phi\theta^2}{125\phi^2+15\phi\theta^2-5\phi-6\theta^2}$$

Firm Surplus:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(2500\phi^3+825\phi^2\theta^2-25\phi^2+900\phi\theta^4-60\phi\theta^2-36\theta^4\right)}{\left(125\phi^2+15\phi\theta^2-5\phi-6\theta^2\right)^2}$$

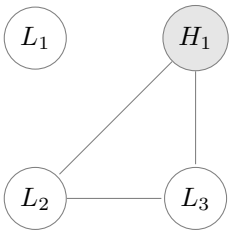
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(10\phi+3\theta^2\right)^2}{\left(125\phi^2+15\phi\theta^2-5\phi-6\theta^2\right)^2}$$

Social Welfare:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(7500\phi^3+3825\phi^2\theta^2-25\phi^2+1350\phi\theta^4-60\phi\theta^2-36\theta^4\right)}{\left(125\phi^2+15\phi\theta^2-5\phi-6\theta^2\right)^2}$$

D.1.9 E3B [1H3L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{2}-2\right) = \alpha - e_1^L\theta + 2e_2^L\theta + 2e_3^L\theta - \bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{4\theta}-4\theta\right) = \alpha - 3e_1^H - 3e_2^L\theta - 3e_3^L\theta - \bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right) = \alpha + 2e_1^H - e_1^L\theta + 2e_3^L\theta - \bar{c} \\ e_3^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right) = \alpha + 2e_1^H - e_1^L\theta + 2e_2^L\theta - \bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{2(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2} \\ e_1^L &= \frac{4\theta(\alpha-\bar{c})\left(5\phi-4\theta^2-2\right)}{125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2} \\ e_2^L &= \frac{2\theta(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2} \\ e_3^L &= \frac{2\theta(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{20\alpha\phi\theta^2+10\alpha\phi-16\alpha\theta^4-8\alpha\theta^2-125\bar{c}\phi^2+100\bar{c}\phi\theta^2+10\bar{c}\phi}{125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2} \\ c_1^L &= -\frac{20\alpha\phi\theta^2-16\alpha\theta^4-8\alpha\theta^2-125\bar{c}\phi^2+100\bar{c}\phi\theta^2+20\bar{c}\phi}{125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2} \\ c_2^L &= -\frac{20\alpha\phi\theta^2+10\alpha\phi-16\alpha\theta^4-8\alpha\theta^2-125\bar{c}\phi^2+100\bar{c}\phi\theta^2+10\bar{c}\phi}{125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2} \\ c_3^L &= -\frac{20\alpha\phi\theta^2+10\alpha\phi-16\alpha\theta^4-8\alpha\theta^2-125\bar{c}\phi^2+100\bar{c}\phi\theta^2+10\bar{c}\phi}{125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-4\theta^2-2\right)}{125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2} \\ q_2^L &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2} \\ q_3^L &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-4\theta^2\right)^2\cdot(25\phi-4)}{(125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2\cdot\left(25\phi-16\theta^2\right)\left(5\phi-4\theta^2-2\right)^2}{(125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2)^2} \\ \pi_2^L &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{(125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2)^2} \\ \pi_3^L &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{(125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2)^2} \end{cases} \tag{40}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(10\phi-8\theta^2-1\right)}{125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2}$$

Price:

$$\frac{25\alpha\phi^2-40\alpha\phi\theta^2-10\alpha\phi+16\alpha\theta^4+8\alpha\theta^2+100\bar{c}\phi^2-80\bar{c}\phi\theta^2-10\bar{c}\phi}{125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2}$$

Firm Surplus:

$$\frac{4\phi\left(\alpha-\bar{c}\right)^2\cdot\left(625\phi^3-1150\phi^2\theta^2-150\phi^2+640\phi\theta^4+220\phi\theta^2+25\phi-96\theta^6-80\theta^4-16\theta^2\right)}{\left(125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2\right)^2}$$

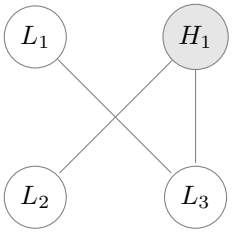
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(10\phi-8\theta^2-1\right)^2}{\left(125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2\right)^2}$$

Social Welfare:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(3750\phi^3-6300\phi^2\theta^2-800\phi^2+2880\phi\theta^4+840\phi\theta^2+75\phi-192\theta^6-160\theta^4-32\theta^2\right)}{\left(125\phi^2-120\phi\theta^2-20\phi+16\theta^4+8\theta^2\right)^2}$$

D.1.10 E3C [1H3L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{2}-2\right) = \alpha-2e_1^L\theta+3e_2^L\theta+2e_3^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right) = \alpha-3e_1^H-2e_2^L\theta+2e_3^L\theta-\bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right) = \alpha+2e_1^H-2e_1^L\theta-3e_3^L\theta-\bar{c} \\ e_3^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right) = \alpha+2e_1^H+3e_1^L\theta-2e_2^L\theta-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{10\phi(\alpha-\bar{c})\left(25\phi^2-15\phi\theta^2-6\theta^4\right)}{3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6} \\ e_1^L &= \frac{3\theta(\alpha-\bar{c})\left(125\phi^3-75\phi^2\theta^2-50\phi^2+12\theta^4\right)}{3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6} \\ e_2^L &= \frac{3\theta(\alpha-\bar{c})\left(125\phi^3-125\phi^2\theta^2+12\theta^4\right)}{3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6} \\ e_3^L &= \frac{10\phi\theta(\alpha-\bar{c})\left(25\phi^2-15\phi\theta^2-6\theta^2\right)}{3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{625\alpha\phi^3\theta^2+250\alpha\phi^3-525\alpha\phi^2\theta^4-150\alpha\phi^2\theta^2-120\alpha\phi\theta^4+36\alpha\theta^6-3125\bar{c}\phi^4+2125\bar{c}\phi^3\theta^2+250\bar{c}\phi^3+300\bar{c}\phi^2\theta^4+150\bar{c}\phi^2\theta^2-120\bar{c}\phi\theta^4}{3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6} \\ c_1^L &= -\frac{625\alpha\phi^3\theta^2-375\alpha\phi^2\theta^4-150\alpha\phi^2\theta^2-60\alpha\phi\theta^4+36\alpha\theta^6-3125\bar{c}\phi^4+2125\bar{c}\phi^3\theta^2+500\bar{c}\phi^3+150\bar{c}\phi^2\theta^4+150\bar{c}\phi^2\theta^2-180\bar{c}\phi\theta^4}{3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6} \\ c_2^L &= -\frac{375\alpha\phi^3\theta^2+250\alpha\phi^3-375\alpha\phi^2\theta^4-150\alpha\phi^2\theta^2-60\alpha\phi\theta^4+36\alpha\theta^6-3125\bar{c}\phi^4+2375\bar{c}\phi^3\theta^2+250\bar{c}\phi^3+150\bar{c}\phi^2\theta^4+150\bar{c}\phi^2\theta^2-180\bar{c}\phi\theta^4}{3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6} \\ c_3^L &= -\frac{625\alpha\phi^3\theta^2+250\alpha\phi^3-375\alpha\phi^2\theta^4-300\alpha\phi^2\theta^2-120\alpha\phi\theta^4+36\alpha\theta^6-3125\bar{c}\phi^4+2125\bar{c}\phi^3\theta^2+250\bar{c}\phi^3+150\bar{c}\phi^2\theta^4+300\bar{c}\phi^2\theta^2-120\bar{c}\phi\theta^4}{3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{25\phi^2(\alpha-\bar{c})\left(25\phi^2-15\phi\theta^2-6\theta^4\right)}{3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})\left(125\phi^3-75\phi^2\theta^2-50\phi^2+12\theta^4\right)}{3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6} \\ q_2^L &= \frac{5\phi(\alpha-\bar{c})\left(125\phi^3-125\phi^2\theta^2+12\theta^4\right)}{3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6} \\ q_3^L &= \frac{25\phi^2(\alpha-\bar{c})\left(25\phi^2-15\phi\theta^2-6\theta^2\right)}{3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{25\phi^3(\alpha-\bar{c})^2\cdot(25\phi-4)\left(25\phi^2-15\phi\theta^2-6\theta^4\right)^2}{(3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2\cdot\left(25\phi-9\theta^2\right)\left(125\phi^3-75\phi^2\theta^2-50\phi^2+12\theta^4\right)^2}{(3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6)^2} \\ \pi_2^L &= \frac{\phi(\alpha-\bar{c})^2\cdot\left(25\phi-9\theta^2\right)\left(125\phi^3-125\phi^2\theta^2+12\theta^4\right)^2}{(3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6)^2} \\ \pi_3^L &= \frac{25\phi^3(\alpha-\bar{c})^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi\theta^2-6\theta^2\right)^2}{(3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6)^2} \end{cases} \tag{41}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(250\phi^3-175\phi^2\theta^2-25\phi^2-15\phi\theta^4-15\phi\theta^2+12\theta^4\right)}{3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6}$$

Price:

$$\frac{625\alpha\phi^4-1000\alpha\phi^3\theta^2-250\alpha\phi^3+375\alpha\phi^2\theta^4+150\alpha\phi^2\theta^2+120\alpha\phi\theta^4-36\alpha\theta^6+2500\bar{c}\phi^4-1750\bar{c}\phi^3\theta^2-250\bar{c}\phi^3-150\bar{c}\phi^2\theta^4-150\bar{c}\phi^2\theta^2+120\bar{c}\phi\theta^4}{3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6}$$

Firm Surplus:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(781250\phi^7-1265625\phi^6\theta^2-187500\phi^6+575000\phi^5\theta^4+93750\phi^5\theta^2+31250\phi^5-50625\phi^4\theta^6+116250\phi^4\theta^4-11250\phi^4\theta^2+11250\phi^3\theta^8-105000\phi^3\theta^6-3750\phi^3\theta^4+19800\phi^2\theta^8+3600\phi^2\theta^6+3600\phi\theta^8-1296\theta^{10}\right)}{\left(3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6\right)^2}$$

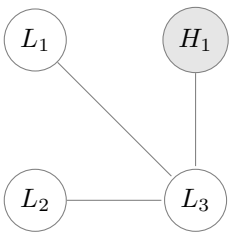
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(250\phi^3-175\phi^2\theta^2-25\phi^2-15\phi\theta^4-15\phi\theta^2+12\theta^4\right)^2}{\left(3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6\right)^2}$$

Social Welfare:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(2343750\phi^7-3453125\phi^6\theta^2-500000\phi^6+1153125\phi^5\theta^4+125000\phi^5\theta^2+46875\phi^5+80625\phi^4\theta^6+416250\phi^4\theta^4+7500\phi^4\theta^2+16875\phi^3\theta^8-198750\phi^3\theta^6-13125\phi^3\theta^4+10800\phi^2\theta^8-5400\phi^2\theta^6+7200\phi\theta^8-1296\theta^{10}\right)}{\left(3125\phi^4-2750\phi^3\theta^2-500\phi^3+225\phi^2\theta^4+240\phi\theta^4-36\theta^6\right)^2}$$

D.1.11 E3D [1H3L]



$$Equations: \begin{cases} e_1^H \cdot \left(\frac{25\phi}{3} - 3\right) = \alpha - 2e_1^L\theta - 2e_2^L\theta + e_3^L\theta - \bar{c} \\ e_1^L \cdot \left(\frac{25\phi}{3\theta} - 3\theta\right) = \alpha - 2e_1^H - 2e_2^L\theta + e_3^L\theta - \bar{c} \\ e_2^L \cdot \left(\frac{25\phi}{3\theta} - 3\theta\right) = \alpha - 2e_1^H - 2e_1^L\theta + e_3^L\theta - \bar{c} \\ e_3^L \cdot \left(\frac{25\phi}{\theta} - \theta\right) = \alpha + 3e_1^H + 3e_1^L\theta + 3e_2^L\theta - \bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{15\phi(\alpha-\bar{c})\left(5\phi-3\theta^2\right)}{625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4} \\ e_1^L &= \frac{15\phi\theta(\alpha-\bar{c})(5\phi-3)}{625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4} \\ e_2^L &= \frac{15\phi\theta(\alpha-\bar{c})(5\phi-3)}{625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4} \\ e_3^L &= \frac{\theta(\alpha-\bar{c})\left(25\phi^2+15\phi\theta^2-18\theta^2\right)}{625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{25\alpha\phi^2\theta^2+75\alpha\phi^2+15\alpha\phi\theta^4-45\alpha\phi\theta^2-18\alpha\theta^4-625\bar{c}\phi^3+75\bar{c}\phi^2\theta^2+150\bar{c}\phi^2+90\bar{c}\phi\theta^2}{625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4} \\ c_1^L &= -\frac{100\alpha\phi^2\theta^2+15\alpha\phi\theta^4-45\alpha\phi\theta^2-18\alpha\theta^4-625\bar{c}\phi^3+225\bar{c}\phi^2+90\bar{c}\phi\theta^2}{625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4} \\ c_2^L &= -\frac{100\alpha\phi^2\theta^2+15\alpha\phi\theta^4-45\alpha\phi\theta^2-18\alpha\theta^4-625\bar{c}\phi^3+225\bar{c}\phi^2+90\bar{c}\phi\theta^2}{625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4} \\ c_3^L &= -\frac{175\alpha\phi^2\theta^2+75\alpha\phi^2+15\alpha\phi\theta^4-135\alpha\phi\theta^2-18\alpha\theta^4-625\bar{c}\phi^3-75\bar{c}\phi^2\theta^2+150\bar{c}\phi^2+180\bar{c}\phi\theta^2}{625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{25\phi^2(\alpha-\bar{c})\left(5\phi-3\theta^2\right)}{625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4} \\ q_1^L &= \frac{25\phi^2(\alpha-\bar{c})(5\phi-3)}{625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4} \\ q_2^L &= \frac{25\phi^2(\alpha-\bar{c})(5\phi-3)}{625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4} \\ q_3^L &= \frac{5\phi(\alpha-\bar{c})\left(25\phi^2+15\phi\theta^2-18\theta^2\right)}{625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{25\phi^3(\alpha-\bar{c})^2\left(5\phi-3\theta^2\right)^2\cdot(25\phi-9)}{(625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4)^2} \\ \pi_1^L &= \frac{25\phi^3(\alpha-\bar{c})^2(5\phi-3)^2\cdot\left(25\phi-9\theta^2\right)}{(625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4)^2} \\ \pi_2^L &= \frac{25\phi^3(\alpha-\bar{c})^2(5\phi-3)^2\cdot\left(25\phi-9\theta^2\right)}{(625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4)^2} \\ \pi_3^L &= \frac{\phi(\alpha-\bar{c})^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2+15\phi\theta^2-18\theta^2\right)^2}{(625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4)^2} \end{cases} \tag{42}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(50\phi^2-15\phi-9\theta^2\right)}{625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4}$$

Price:

$$\frac{125\alpha\phi^3-100\alpha\phi^2\theta^2-75\alpha\phi^2-15\alpha\phi\theta^4+45\alpha\phi\theta^2+18\alpha\theta^4+500\bar{c}\phi^3-150\bar{c}\phi^2-90\bar{c}\phi\theta^2}{625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4}$$

Firm Surplus:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(62500\phi^5-11875\phi^4\theta^2-43125\phi^4+10500\phi^3\theta^4-2250\phi^3\theta^2+11250\phi^3-225\phi^2\theta^6-14625\phi^2\theta^4-4050\phi^2\theta^2+540\phi\theta^6+8100\phi\theta^4-324\theta^6\right)}{\left(625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4\right)^2}$$

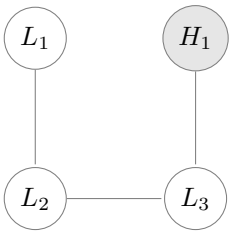
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(50\phi^2-15\phi-9\theta^2\right)^2}{\left(625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4\right)^2}$$

Social Welfare:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(187500\phi^5-11875\phi^4\theta^2-118125\phi^4+10500\phi^3\theta^4-47250\phi^3\theta^2+22500\phi^3-225\phi^2\theta^6-14625\phi^2\theta^4+9450\phi^2\theta^2+540\phi\theta^6+12150\phi\theta^4-324\theta^6\right)}{\left(625\phi^3-100\phi^2\theta^2-225\phi^2-15\phi\theta^4-45\phi\theta^2+18\theta^4\right)^2}$$

D.1.12 E3E [1H3L]



$$Equations: \begin{cases} e_1^H \cdot \left(\frac{25\phi}{3} - 3\right) = \alpha - 2e_1^L\theta - 3e_2^L\theta + 2e_3^L\theta - \bar{c} \\ e_1^L \cdot \left(\frac{25\phi}{3\theta} - 3\theta\right) = \alpha - 2e_1^H + 2e_2^L\theta - 3e_3^L\theta - \bar{c} \\ e_2^L \cdot \left(\frac{25\phi}{2\theta} - 2\theta\right) = \alpha - 2e_1^H + 3e_1^L\theta + 2e_3^L\theta - \bar{c} \\ e_3^L \cdot \left(\frac{25\phi}{2\theta} - 2\theta\right) = \alpha + 3e_1^H - 2e_1^L\theta + 2e_2^L\theta - \bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{3(\alpha-\bar{c})\left(5\phi-2\theta^2\right)\left(25\phi^2-15\phi\theta^2-6\theta^4\right)}{3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6} \\ e_1^L &= \frac{3\theta(\alpha-\bar{c})\left(5\phi-2\theta^2\right)\left(25\phi^2-15\phi-6\theta^2\right)}{3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6} \\ e_2^L &= \frac{10\phi\theta(\alpha-\bar{c})\left(25\phi^2-15\phi-6\theta^4\right)}{3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6} \\ e_3^L &= \frac{10\phi\theta(\alpha-\bar{c})\left(25\phi^2-15\phi\theta^2-6\theta^2\right)}{3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{250\alpha\phi^3\theta^2+375\alpha\phi^3-150\alpha\phi^2\theta^4-375\alpha\phi^2\theta^2-60\alpha\phi\theta^4+36\alpha\theta^6-3125\bar{c}\phi^4+1875\bar{c}\phi^3\theta^2+750\bar{c}\phi^3+150\bar{c}\phi^2\theta^4+150\bar{c}\phi^2\theta^2-120\bar{c}\phi\theta^6-60\bar{c}\phi\theta^4}{3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6} \\ c_1^L &= -\frac{625\alpha\phi^3\theta^2-150\alpha\phi^2\theta^4-375\alpha\phi^2\theta^2-60\alpha\phi\theta^6+36\alpha\theta^6-3125\bar{c}\phi^4+1500\bar{c}\phi^3\theta^2+1125\bar{c}\phi^3+150\bar{c}\phi^2\theta^4+150\bar{c}\phi^2\theta^2-60\bar{c}\phi\theta^6-120\bar{c}\phi\theta^4}{3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6} \\ c_2^L &= -\frac{875\alpha\phi^3\theta^2-300\alpha\phi^2\theta^4-375\alpha\phi^2\theta^2-60\alpha\phi\theta^6-60\alpha\phi\theta^4+36\alpha\theta^6-3125\bar{c}\phi^4+1250\bar{c}\phi^3\theta^2+1125\bar{c}\phi^3+300\bar{c}\phi^2\theta^4+150\bar{c}\phi^2\theta^2-60\bar{c}\phi\theta^6-60\bar{c}\phi\theta^4}{3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6} \\ c_3^L &= -\frac{500\alpha\phi^3\theta^2+375\alpha\phi^3-150\alpha\phi^2\theta^4-525\alpha\phi^2\theta^2-60\alpha\phi\theta^6-60\alpha\phi\theta^4+36\alpha\theta^6-3125\bar{c}\phi^4+1625\bar{c}\phi^3\theta^2+750\bar{c}\phi^3+150\bar{c}\phi^2\theta^4+300\bar{c}\phi^2\theta^2-60\bar{c}\phi\theta^6-60\bar{c}\phi\theta^4}{3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-2\theta^2\right)\left(25\phi^2-15\phi\theta^2-6\theta^4\right)}{3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-2\theta^2\right)\left(25\phi^2-15\phi-6\theta^2\right)}{3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6} \\ q_2^L &= \frac{25\phi^2(\alpha-\bar{c})\left(25\phi^2-15\phi-6\theta^4\right)}{3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6} \\ q_3^L &= \frac{25\phi^2(\alpha-\bar{c})\left(25\phi^2-15\phi\theta^2-6\theta^2\right)}{3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-2\theta^2\right)^2\cdot(25\phi-9)\left(25\phi^2-15\phi\theta^2-6\theta^4\right)^2}{(3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-2\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)\left(25\phi^2-15\phi-6\theta^2\right)^2}{(3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6)^2} \\ \pi_2^L &= \frac{25\phi^3(\alpha-\bar{c})^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi-6\theta^4\right)^2}{(3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6)^2} \\ \pi_3^L &= \frac{25\phi^3(\alpha-\bar{c})^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi\theta^2-6\theta^2\right)^2}{(3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6)^2} \end{cases} \tag{43}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(5\phi-\theta^2\right)\left(50\phi^2-15\phi\theta^2-15\phi-6\theta^4-6\theta^2\right)}{3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6}$$

Price:

$$\frac{625\alpha\phi^4-875\alpha\phi^3\theta^2-375\alpha\phi^3+150\alpha\phi^2\theta^4+375\alpha\phi^2\theta^2+60\alpha\phi\theta^6+60\alpha\phi\theta^4-36\alpha\theta^6+2500\bar{c}\phi^4-1250\bar{c}\phi^3\theta^2-750\bar{c}\phi^3-150\bar{c}\phi^2\theta^4-150\bar{c}\phi^2\theta^2+60\bar{c}\phi\theta^6+60\bar{c}\phi\theta^4}{3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6}$$

Firm Surplus:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(1562500\phi^7-1828125\phi^6\theta^2-1078125\phi^6+593750\phi^5\theta^4+525000\phi^5\theta^2+281250\phi^5+60000\phi^4\theta^6+121875\phi^4\theta^4-73125\phi^4\theta^2-52500\phi^3\theta^8-120000\phi^3\theta^6-22500\phi^3\theta^4-3600\phi^2\theta^{10}+37800\phi^2\theta^8+12600\phi^2\theta^6+3600\phi\theta^{12}+3600\phi\theta^8-1296\theta^{12}-1296\theta^{10}\right)}{\left(3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6\right)^2}$$

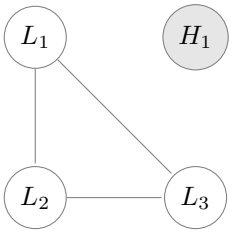
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(5\phi-\theta^2\right)^2\left(50\phi^2-15\phi\theta^2-15\phi-6\theta^4-6\theta^2\right)^2}{\left(3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6\right)^2}$$

Social Welfare:

$$\frac{\phi\,(\alpha-\bar{c})^2\cdot\left(4687500\phi^7-4953125\phi^6\theta^2-2953125\phi^6+1000000\phi^5\theta^4+1087500\phi^5\theta^2+562500\phi^5+397500\phi^4\theta^6+571875\phi^4\theta^4+39375\phi^4\theta^2-116250\phi^3\theta^8-217500\phi^3\theta^6-56250\phi^3\theta^4-12600\phi^2\theta^{10}+19800\phi^2\theta^8+3600\phi^2\theta^6+5400\phi\theta^{12}+3600\phi\theta^{10}+5400\phi\theta^8-1296\theta^{12}-1296\theta^{10}\right)}{\left(3125\phi^4-2125\phi^3\theta^2-1125\phi^3+225\phi^2\theta^2+120\phi\theta^6+120\phi\theta^4-36\theta^6\right)^2}$$

D.1.13 E3F [1H3L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{4}-4\right)=\alpha-3e_1^L\theta-3e_2^L\theta-3e_3^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right)=\alpha-e_1^H+2e_2^L\theta+2e_3^L\theta-\bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right)=\alpha-e_1^H+2e_1^L\theta+2e_3^L\theta-\bar{c} \\ e_3^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right)=\alpha-e_1^H+2e_1^L\theta+2e_2^L\theta-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{4(\alpha-\bar{c})\left(5\phi-6\theta^2\right)}{125\phi^2-60\phi\theta^2-80\phi+24\theta^2} \\ e_1^L &= \frac{2\theta(\alpha-\bar{c})(5\phi-4)}{125\phi^2-60\phi\theta^2-80\phi+24\theta^2} \\ e_2^L &= \frac{2\theta(\alpha-\bar{c})(5\phi-4)}{125\phi^2-60\phi\theta^2-80\phi+24\theta^2} \\ e_3^L &= \frac{2\theta(\alpha-\bar{c})(5\phi-4)}{125\phi^2-60\phi\theta^2-80\phi+24\theta^2} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{20\alpha\phi-24\alpha\theta^2-125\bar{c}\phi^2+60\bar{c}\phi\theta^2+60\bar{c}\phi}{125\phi^2-60\phi\theta^2-80\phi+24\theta^2} \\ c_1^L &= -\frac{30\alpha\phi\theta^2-24\alpha\theta^2-125\bar{c}\phi^2+30\bar{c}\phi\theta^2+80\bar{c}\phi}{125\phi^2-60\phi\theta^2-80\phi+24\theta^2} \\ c_2^L &= -\frac{30\alpha\phi\theta^2-24\alpha\theta^2-125\bar{c}\phi^2+30\bar{c}\phi\theta^2+80\bar{c}\phi}{125\phi^2-60\phi\theta^2-80\phi+24\theta^2} \\ c_3^L &= -\frac{30\alpha\phi\theta^2-24\alpha\theta^2-125\bar{c}\phi^2+30\bar{c}\phi\theta^2+80\bar{c}\phi}{125\phi^2-60\phi\theta^2-80\phi+24\theta^2} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-6\theta^2\right)}{125\phi^2-60\phi\theta^2-80\phi+24\theta^2} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-4)}{125\phi^2-60\phi\theta^2-80\phi+24\theta^2} \\ q_2^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-4)}{125\phi^2-60\phi\theta^2-80\phi+24\theta^2} \\ q_3^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-4)}{125\phi^2-60\phi\theta^2-80\phi+24\theta^2} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-6\theta^2\right)^2\cdot(25\phi-16)}{\left(125\phi^2-60\phi\theta^2-80\phi+24\theta^2\right)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-4)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-60\phi\theta^2-80\phi+24\theta^2\right)^2} \\ \pi_2^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-4)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-60\phi\theta^2-80\phi+24\theta^2\right)^2} \\ \pi_3^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-4)^2\cdot\left(25\phi-4\theta^2\right)}{\left(125\phi^2-60\phi\theta^2-80\phi+24\theta^2\right)^2} \end{cases} \tag{44}$$

Total Production:

$$\frac{10\phi\,(\alpha-\bar{c})\left(10\phi-3\theta^2-6\right)}{125\phi^2-60\phi\theta^2-80\phi+24\theta^2}$$

Price:

$$\frac{25\alpha\phi^2-30\alpha\phi\theta^2-20\alpha\phi+24\alpha\theta^2+100\bar{c}\phi^2-30\bar{c}\phi\theta^2-60\bar{c}\phi}{125\phi^2-60\phi\theta^2-80\phi+24\theta^2}$$

Firm Surplus:

$$\frac{4\phi\,(\alpha-\bar{c})^2\cdot\left(625\phi^3-450\phi^2\theta^2-850\phi^2+225\phi\theta^4+360\phi\theta^2+300\phi-144\theta^4-48\theta^2\right)}{\left(125\phi^2-60\phi\theta^2-80\phi+24\theta^2\right)^2}$$

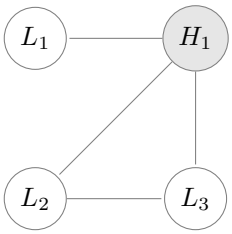
Consumer Surplus:

$$\frac{50\phi^2\,(\alpha-\bar{c})^2\left(10\phi-3\theta^2-6\right)^2}{\left(125\phi^2-60\phi\theta^2-80\phi+24\theta^2\right)^2}$$

Social Welfare:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(3750\phi^3-2400\phi^2\theta^2-4700\phi^2+675\phi\theta^4+1620\phi\theta^2+1500\phi-288\theta^4-96\theta^2\right)}{\left(125\phi^2-60\phi\theta^2-80\phi+24\theta^2\right)^2}$$

D.1.14 E4A [1H3L]



$$Equations: \begin{cases} e_1^H\cdot(25\phi-1)=\alpha+3e_1^L\theta+2e_2^L\theta+2e_3^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right)=\alpha+e_1^H-3e_2^L\theta-3e_3^L\theta-\bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right)=\alpha+e_1^H-2e_1^L\theta+2e_3^L\theta-\bar{c} \\ e_3^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right)=\alpha+e_1^H-2e_1^L\theta+2e_2^L\theta-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{(\alpha-\bar{c})\left(25\phi^2-12\theta^4\right)}{625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4} \\ e_1^L &= \frac{15\phi\theta(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4} \\ e_2^L &= \frac{10\phi\theta(\alpha-\bar{c})\left(5\phi-3\theta^2\right)}{625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4} \\ e_3^L &= \frac{10\phi\theta(\alpha-\bar{c})\left(5\phi-3\theta^2\right)}{625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{175\alpha\phi^2\theta^2+25\alpha\phi^2-120\alpha\phi\theta^4-12\alpha\theta^4-625\bar{c}\phi^3+250\bar{c}\phi^2\theta^2+120\bar{c}\phi\theta^4}{625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4} \\ c_1^L &= -\frac{75\alpha\phi^2\theta^2+25\alpha\phi^2-60\alpha\phi\theta^4-12\alpha\theta^4-625\bar{c}\phi^3+350\bar{c}\phi^2\theta^2+60\bar{c}\phi\theta^4}{625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4} \\ c_2^L &= -\frac{100\alpha\phi^2\theta^2+25\alpha\phi^2-60\alpha\phi\theta^4-12\alpha\theta^4-625\bar{c}\phi^3+325\bar{c}\phi^2\theta^2+60\bar{c}\phi\theta^4}{625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4} \\ c_3^L &= -\frac{100\alpha\phi^2\theta^2+25\alpha\phi^2-60\alpha\phi\theta^4-12\alpha\theta^4-625\bar{c}\phi^3+325\bar{c}\phi^2\theta^2+60\bar{c}\phi\theta^4}{625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})\left(25\phi^2-12\theta^4\right)}{625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4} \\ q_1^L &= \frac{25\phi^2(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4} \\ q_2^L &= \frac{25\phi^2(\alpha-\bar{c})\left(5\phi-3\theta^2\right)}{625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4} \\ q_3^L &= \frac{25\phi^2(\alpha-\bar{c})\left(5\phi-3\theta^2\right)}{625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\cdot(25\phi-1)\left(25\phi^2-12\theta^4\right)^2}{\left(625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4\right)^2} \\ \pi_1^L &= \frac{25\phi^3(\alpha-\bar{c})^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{\left(625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4\right)^2} \\ \pi_2^L &= \frac{25\phi^3(\alpha-\bar{c})^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4\right)^2} \\ \pi_3^L &= \frac{25\phi^3(\alpha-\bar{c})^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4\right)^2} \end{cases} \tag{45}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(50\phi^2-25\phi\theta^2-6\theta^4\right)}{625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4}$$

Price:

$$\frac{125\alpha\phi^3-175\alpha\phi^2\theta^2-25\alpha\phi^2+60\alpha\phi\theta^4+12\alpha\theta^4+500\bar{c}\phi^3-250\bar{c}\phi^2\theta^2-60\bar{c}\phi\theta^4}{625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4}$$

Firm Surplus:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(62500\phi^5-73125\phi^4\theta^2-625\phi^4+21250\phi^3\theta^4-5400\phi^2\theta^6+600\phi^2\theta^4+3600\phi\theta^8-144\theta^8\right)}{\left(625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4\right)^2}$$

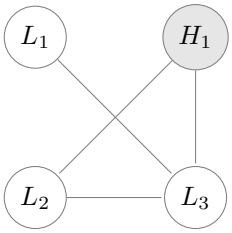
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(50\phi^2-25\phi\theta^2-6\theta^4\right)^2}{\left(625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4\right)^2}$$

Social Welfare:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(187500\phi^5-198125\phi^4\theta^2-625\phi^4+22500\phi^3\theta^4+9600\phi^2\theta^6+600\phi^2\theta^4+5400\phi\theta^8-144\theta^8\right)}{\left(625\phi^3-425\phi^2\theta^2-25\phi^2+12\theta^4\right)^2}$$

D.1.15 E4B [1H3L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{2}-2\right)=\alpha-2e_1^L\theta+2e_2^L\theta+e_3^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right)=\alpha-3e_1^H-3e_2^L\theta+e_3^L\theta-\bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right)=\alpha+2e_1^H-2e_1^L\theta+e_3^L\theta-\bar{c} \\ e_3^L\cdot\left(\frac{25\phi}{\theta}-\theta\right)=\alpha+2e_1^H+3e_1^L\theta+2e_2^L\theta-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{10\phi(\alpha-\bar{c})\left(5\phi-3\theta^2\right)}{625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4} \\ e_1^L &= \frac{15\phi\theta(\alpha-\bar{c})\left(5\phi-2\theta^2-2\right)}{625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4} \\ e_2^L &= \frac{10\phi\theta(\alpha-\bar{c})\left(5\phi-3\theta^2\right)}{625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4} \\ e_3^L &= \frac{\theta(\alpha-\bar{c})\left(25\phi^2-6\theta^4-6\theta^2\right)}{625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{75\alpha\phi^2\theta^2+50\alpha\phi^2-30\alpha\phi\theta^4-30\alpha\phi\theta^2-6\alpha\theta^6-6\alpha\theta^4-625\bar{c}\phi^3+275\bar{c}\phi^2\theta^2+50\bar{c}\phi^2+30\bar{c}\phi\theta^4+30\bar{c}\phi\theta^2}{625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4} \\ c_1^L &= -\frac{100\alpha\phi^2\theta^2-30\alpha\phi\theta^4-30\alpha\phi\theta^2-6\alpha\theta^6-6\alpha\theta^4-625\bar{c}\phi^3+250\bar{c}\phi^2\theta^2+100\bar{c}\phi^2+30\bar{c}\phi\theta^4+30\bar{c}\phi\theta^2}{625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4} \\ c_2^L &= -\frac{75\alpha\phi^2\theta^2+50\alpha\phi^2-30\alpha\phi\theta^4-30\alpha\phi\theta^2-6\alpha\theta^6-6\alpha\theta^4-625\bar{c}\phi^3+275\bar{c}\phi^2\theta^2+50\bar{c}\phi^2+30\bar{c}\phi\theta^4+30\bar{c}\phi\theta^2}{625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4} \\ c_3^L &= -\frac{150\alpha\phi^2\theta^2+50\alpha\phi^2-60\alpha\phi\theta^4-60\alpha\phi\theta^2-6\alpha\theta^6-6\alpha\theta^4-625\bar{c}\phi^3+200\bar{c}\phi^2\theta^2+50\bar{c}\phi^2+60\bar{c}\phi\theta^4+60\bar{c}\phi\theta^2}{625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{25\phi^2(\alpha-\bar{c})\left(5\phi-3\theta^2\right)}{625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4} \\ q_1^L &= \frac{25\phi^2(\alpha-\bar{c})\left(5\phi-2\theta^2-2\right)}{625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4} \\ q_2^L &= \frac{25\phi^2(\alpha-\bar{c})\left(5\phi-3\theta^2\right)}{625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4} \\ q_3^L &= \frac{5\phi(\alpha-\bar{c})\left(25\phi^2-6\theta^4-6\theta^2\right)}{625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{25\phi^3(\alpha-\bar{c})^2\left(5\phi-3\theta^2\right)^2\cdot(25\phi-4)}{(625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4)^2} \\ \pi_1^L &= \frac{25\phi^3(\alpha-\bar{c})^2\cdot\left(25\phi-9\theta^2\right)\left(5\phi-2\theta^2-2\right)^2}{(625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4)^2} \\ \pi_2^L &= \frac{25\phi^3(\alpha-\bar{c})^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{(625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4)^2} \\ \pi_3^L &= \frac{\phi(\alpha-\bar{c})^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2-6\theta^4-6\theta^2\right)^2}{(625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4)^2} \end{cases} \tag{46}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(50\phi^2-20\phi\theta^2-5\phi-3\theta^4-3\theta^2\right)}{625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4}$$

Price:

$$\frac{125\alpha\phi^3-150\alpha\phi^2\theta^2-50\alpha\phi^2+30\alpha\phi\theta^4+30\alpha\phi\theta^2+6\alpha\theta^6+6\alpha\theta^4+500\bar{c}\phi^3-200\bar{c}\phi^2\theta^2-50\bar{c}\phi^2-30\bar{c}\phi\theta^4-30\bar{c}\phi\theta^2}{625\phi^3-350\phi^2\theta^2-100\phi^2+6\theta^6+6\theta^4}$$

Firm Surplus:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^{2}\cdot\left(31250\phi^{5}-29375\phi^{4}\theta^{2}-7500\phi^{4}+6875\phi^{3}\theta^{4}+2500\phi^{3}\theta^{2}+1250\phi^{3}-750\phi^{2}\theta^{6}-1200\phi^{2}\theta^{4}-450\phi^{2}\theta^{2}+450\phi\theta^{8}+900\phi\theta^{6}+450\phi\theta^{4}-18\theta^{10}-36\theta^{8}-18\theta^{6}\right)}{\left(625\phi^{3}-350\phi^{2}\theta^{2}-100\phi^{2}+6\theta^{6}+6\theta^{4}\right)^{2}}$$

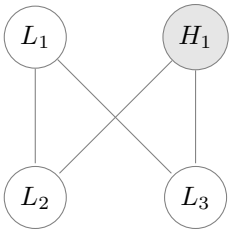
Consumer Surplus:

$$\frac{50\phi^{2}\left(\alpha-\bar{c}\right)^{2}\left(50\phi^{2}-20\phi\theta^{2}-5\phi-3\theta^{4}-3\theta^{2}\right)^{2}}{\left(625\phi^{3}-350\phi^{2}\theta^{2}-100\phi^{2}+6\theta^{6}+6\theta^{4}\right)^{2}}$$

Social Welfare:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^{2}\cdot\left(93750\phi^{5}-79375\phi^{4}\theta^{2}-20000\phi^{4}+9375\phi^{3}\theta^{4}+1875\phi^{3}+2250\phi^{2}\theta^{6}+2550\phi^{2}\theta^{4}+300\phi^{2}\theta^{2}+675\phi\theta^{8}+1350\phi\theta^{6}+675\phi\theta^{4}-18\theta^{10}-36\theta^{8}-18\theta^{6}\right)}{\left(625\phi^{3}-350\phi^{2}\theta^{2}-100\phi^{2}+6\theta^{6}+6\theta^{4}\right)^{2}}$$

D.1.16 E4C [1H3L]



$$Equations: \begin{cases} e_1^H \cdot \left(\frac{25\phi}{2}-2\right) = \alpha - 3e_1^L\theta + 2e_2^L\theta + 2e_3^L\theta - \bar{c} \\ e_1^L \cdot \left(\frac{25\phi}{2\theta}-2\theta\right) = \alpha - 3e_1^H + 2e_2^L\theta + 2e_3^L\theta - \bar{c} \\ e_2^L \cdot \left(\frac{25\phi}{2\theta}-2\theta\right) = \alpha + 2e_1^H + 2e_1^L\theta - 3e_3^L\theta - \bar{c} \\ e_3^L \cdot \left(\frac{25\phi}{2\theta}-2\theta\right) = \alpha + 2e_1^H + 2e_1^L\theta - 3e_2^L\theta - \bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{2(\alpha-\bar{c})\left(5\phi-2\theta^2\right)\left(5\phi+2\theta^2\right)}{625\phi^3-50\phi^2\theta^2-100\phi^2-40\phi\theta^4-60\phi\theta^2+24\theta^4} \\ e_1^L &= \frac{2\theta(\alpha-\bar{c})(5\phi-2)\left(5\phi+2\theta^2\right)}{625\phi^3-50\phi^2\theta^2-100\phi^2-40\phi\theta^4-60\phi\theta^2+24\theta^4} \\ e_2^L &= \frac{2\theta(\alpha-\bar{c})(5\phi-2\theta)(5\phi+2\theta)}{625\phi^3-50\phi^2\theta^2-100\phi^2-40\phi\theta^4-60\phi\theta^2+24\theta^4} \\ e_3^L &= \frac{2\theta(\alpha-\bar{c})(5\phi-2\theta)(5\phi+2\theta)}{625\phi^3-50\phi^2\theta^2-100\phi^2-40\phi\theta^4-60\phi\theta^2+24\theta^4} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{100\alpha\phi^2\theta^2+50\alpha\phi^2-24\alpha\theta^4-625\bar{c}\phi^3-50\bar{c}\phi^2\theta^2+50\bar{c}\phi^2+40\bar{c}\phi\theta^4+60\bar{c}\phi\theta^2}{625\phi^3-50\phi^2\theta^2-100\phi^2-40\phi\theta^4-60\phi\theta^2+24\theta^4} \\ c_1^L &= -\frac{150\alpha\phi^2\theta^2+20\alpha\phi\theta^4-20\alpha\phi\theta^2-24\alpha\theta^4-625\bar{c}\phi^3-100\bar{c}\phi^2\theta^2+100\bar{c}\phi^2+20\bar{c}\phi\theta^4+80\bar{c}\phi\theta^2}{625\phi^3-50\phi^2\theta^2-100\phi^2-40\phi\theta^4-60\phi\theta^2+24\theta^4} \\ c_2^L &= -\frac{100\alpha\phi^2\theta^2+50\alpha\phi^2+20\alpha\phi\theta^4-20\alpha\phi\theta^2-24\alpha\theta^4-625\bar{c}\phi^3-50\bar{c}\phi^2\theta^2+50\bar{c}\phi^2+20\bar{c}\phi\theta^4+80\bar{c}\phi\theta^2}{625\phi^3-50\phi^2\theta^2-100\phi^2-40\phi\theta^4-60\phi\theta^2+24\theta^4} \\ c_3^L &= -\frac{100\alpha\phi^2\theta^2+50\alpha\phi^2+20\alpha\phi\theta^4-20\alpha\phi\theta^2-24\alpha\theta^4-625\bar{c}\phi^3-50\bar{c}\phi^2\theta^2+50\bar{c}\phi^2+20\bar{c}\phi\theta^4+80\bar{c}\phi\theta^2}{625\phi^3-50\phi^2\theta^2-100\phi^2-40\phi\theta^4-60\phi\theta^2+24\theta^4} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-2\theta^2\right)\left(5\phi+2\theta^2\right)}{625\phi^3-50\phi^2\theta^2-100\phi^2-40\phi\theta^4-60\phi\theta^2+24\theta^4} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-2)\left(5\phi+2\theta^2\right)}{625\phi^3-50\phi^2\theta^2-100\phi^2-40\phi\theta^4-60\phi\theta^2+24\theta^4} \\ q_2^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-2\theta)(5\phi+2\theta)}{625\phi^3-50\phi^2\theta^2-100\phi^2-40\phi\theta^4-60\phi\theta^2+24\theta^4} \\ q_3^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-2\theta)(5\phi+2\theta)}{625\phi^3-50\phi^2\theta^2-100\phi^2-40\phi\theta^4-60\phi\theta^2+24\theta^4} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-2\theta^2\right)^2\left(5\phi+2\theta^2\right)^2\cdot(25\phi-4)}{(625\phi^3-50\phi^2\theta^2-100\phi^2-40\phi\theta^4-60\phi\theta^2+24\theta^4)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-2)^2\left(5\phi+2\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{(625\phi^3-50\phi^2\theta^2-100\phi^2-40\phi\theta^4-60\phi\theta^2+24\theta^4)^2} \\ \pi_2^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-2\theta)^2(5\phi+2\theta)^2\cdot\left(25\phi-4\theta^2\right)}{(625\phi^3-50\phi^2\theta^2-100\phi^2-40\phi\theta^4-60\phi\theta^2+24\theta^4)^2} \\ \pi_3^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-2\theta)^2(5\phi+2\theta)^2\cdot\left(25\phi-4\theta^2\right)}{(625\phi^3-50\phi^2\theta^2-100\phi^2-40\phi\theta^4-60\phi\theta^2+24\theta^4)^2} \end{cases} \tag{47}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(50\phi^{2}+5\phi\theta^{2}-5\phi-2\theta^{4}-6\theta^{2}\right)}{625\phi^{3}-50\phi^{2}\theta^{2}-100\phi^{2}-40\phi\theta^{4}-60\phi\theta^{2}+24\theta^{4}}$$

Price:

$$\frac{125\alpha\phi^3-100\alpha\phi^2\theta^2-50\alpha\phi^2-20\alpha\phi\theta^4+24\alpha\theta^4+500\bar{c}\phi^3+50\bar{c}\phi^2\theta^2-50\bar{c}\phi^2-20\bar{c}\phi\theta^4-60\bar{c}\phi\theta^2}{625\phi^3-50\phi^2\theta^2-100\phi^2-40\phi\theta^4-60\phi\theta^2+24\theta^4}$$

Firm Surplus:

$$\frac{4\phi\left(\alpha-\bar{c}\right)^2\cdot\left(15625\phi^5+1250\phi^4\theta^2-3750\phi^4-1125\phi^3\theta^4-4500\phi^3\theta^2+625\phi^3-100\phi^2\theta^6+500\phi^2\theta^4+400\phi^2\theta^2+100\phi\theta^8+80\phi\theta^6+220\phi\theta^4-16\theta^8-48\theta^6\right)}{\left(625\phi^3-50\phi^2\theta^2-100\phi^2-40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}$$

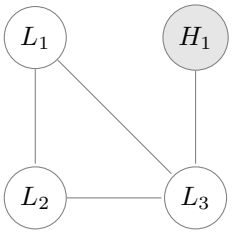
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(50\phi^2+5\phi\theta^2-5\phi-2\theta^4-6\theta^2\right)^2}{\left(625\phi^3-50\phi^2\theta^2-100\phi^2-40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}$$

Social Welfare:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(93750\phi^5+15000\phi^4\theta^2-20000\phi^4-6625\phi^3\theta^4-25250\phi^3\theta^2+1875\phi^3-700\phi^2\theta^6+2300\phi^2\theta^2+300\phi\theta^8+760\phi\theta^6+1340\phi\theta^4-32\theta^8-96\theta^6\right)}{\left(625\phi^3-50\phi^2\theta^2-100\phi^2-40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}$$

D.1.17 E4D [1H3L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{3}-3\right)=\alpha-3e_1^L\theta-3e_2^L\theta+e_3^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right)=\alpha-2e_1^H+2e_2^L\theta+e_3^L\theta-\bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right)=\alpha-2e_1^H+2e_1^L\theta+e_3^L\theta-\bar{c} \\ e_3^L\cdot\left(\frac{25\phi}{\theta}-\theta\right)=\alpha+3e_1^H+2e_1^L\theta+2e_2^L\theta-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{15\phi(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^4} \\ e_1^L &= \frac{10\phi\theta(\alpha-\bar{c})(5\phi-3)}{625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^4} \\ e_2^L &= \frac{10\phi\theta(\alpha-\bar{c})(5\phi-3)}{625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^4} \\ e_3^L &= \frac{\theta(\alpha-\bar{c})\left(25\phi^2-12\theta^2\right)}{625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^4} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{25\alpha\phi^2\theta^2+75\alpha\phi^2-60\alpha\phi\theta^2-12\alpha\theta^4-625\bar{c}\phi^3+200\bar{c}\phi^2\theta^2+150\bar{c}\phi^2+60\bar{c}\phi\theta^2}{625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^4} \\ c_1^L &= -\frac{125\alpha\phi^2\theta^2-60\alpha\phi\theta^2-12\alpha\theta^4-625\bar{c}\phi^3+100\bar{c}\phi^2\theta^2+225\bar{c}\phi^2+60\bar{c}\phi\theta^2}{625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^4} \\ c_2^L &= -\frac{125\alpha\phi^2\theta^2-60\alpha\phi\theta^2-12\alpha\theta^4-625\bar{c}\phi^3+100\bar{c}\phi^2\theta^2+225\bar{c}\phi^2+60\bar{c}\phi\theta^2}{625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^4} \\ c_3^L &= -\frac{125\alpha\phi^2\theta^2+75\alpha\phi^2-120\alpha\phi\theta^2-12\alpha\theta^4-625\bar{c}\phi^3+100\bar{c}\phi^2\theta^2+150\bar{c}\phi^2+120\bar{c}\phi\theta^2}{625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^4} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{25\phi^2(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^4} \\ q_1^L &= \frac{25\phi^2(\alpha-\bar{c})(5\phi-3)}{625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^4} \\ q_2^L &= \frac{25\phi^2(\alpha-\bar{c})(5\phi-3)}{625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^4} \\ q_3^L &= \frac{5\phi(\alpha-\bar{c})\left(25\phi^2-12\theta^2\right)}{625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^4} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{25\phi^3(\alpha-\bar{c})^2\left(5\phi-4\theta^2\right)^2\cdot(25\phi-9)}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^4\right)^2} \\ \pi_1^L &= \frac{25\phi^3(\alpha-\bar{c})^2(5\phi-3)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^4\right)^2} \\ \pi_2^L &= \frac{25\phi^3(\alpha-\bar{c})^2(5\phi-3)^2\cdot\left(25\phi-4\theta^2\right)}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^4\right)^2} \\ \pi_3^L &= \frac{\phi(\alpha-\bar{c})^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2-12\theta^2\right)^2}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^4\right)^2} \end{cases} \tag{48}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(50\phi^2-10\phi\theta^2-15\phi-6\theta^2\right)}{625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^4}$$

Price:

$$\frac{125\alpha\phi^3-125\alpha\phi^2\theta^2-75\alpha\phi^2+60\alpha\phi\theta^2+12\alpha\theta^4+500\bar{c}\phi^3-100\bar{c}\phi^2\theta^2-150\bar{c}\phi^2-60\bar{c}\phi\theta^2}{625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^4}$$

Firm Surplus:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(62500\phi^5-30625\phi^4\theta^2-43125\phi^4+10000\phi^3\theta^4+11250\phi^3-3000\phi^2\theta^4-1800\phi^2\theta^2+3600\phi\theta^4-144\theta^6\right)}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^4\right)^2}$$

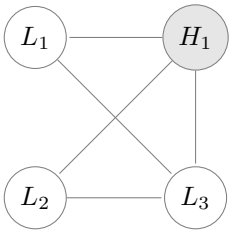
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(50\phi^2-10\phi\theta^2-15\phi-6\theta^2\right)^2}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^4\right)^2}$$

Social Welfare:

$$\frac{3\phi\left(\alpha-\bar{c}\right)^2\cdot\left(62500\phi^5-26875\phi^4\theta^2-39375\phi^4+5000\phi^3\theta^4-5000\phi^3\theta^2+7500\phi^3+1000\phi^2\theta^4+2400\phi^2\theta^2+1800\phi\theta^4-48\theta^6\right)}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^4\right)^2}$$

D.1.18 E5A [1H3L]



$$Equations: \begin{cases} e_1^H\cdot(25\phi-1)=\alpha+2e_1^L\theta+2e_2^L\theta+e_3^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right)=\alpha+e_1^H-3e_2^L\theta+e_3^L\theta-\bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right)=\alpha+e_1^H-3e_1^L\theta+e_3^L\theta-\bar{c} \\ e_3^L\cdot\left(\frac{25\phi}{\theta}-\theta\right)=\alpha+e_1^H+2e_1^L\theta+2e_2^L\theta-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{(\alpha-\bar{c})\left(5\phi+2\theta^2\right)}{125\phi^2+5\phi\theta^2-5\phi-2\theta^4-2\theta^2} \\ e_1^L &= \frac{10\phi\theta(\alpha-\bar{c})}{125\phi^2+5\phi\theta^2-5\phi-2\theta^4-2\theta^2} \\ e_2^L &= \frac{10\phi\theta(\alpha-\bar{c})}{125\phi^2+5\phi\theta^2-5\phi-2\theta^4-2\theta^2} \\ e_3^L &= \frac{\theta(\alpha-\bar{c})\left(5\phi+2\theta^2\right)}{125\phi^2+5\phi\theta^2-5\phi-2\theta^4-2\theta^2} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{25\alpha\phi\theta^2+5\alpha\phi+2\alpha\theta^4+2\alpha\theta^2-125\bar{c}\phi^2-30\bar{c}\phi\theta^2}{125\phi^2+5\phi\theta^2-5\phi-2\theta^4-2\theta^2} \\ c_1^L &= -\frac{15\alpha\phi\theta^2+5\alpha\phi+2\alpha\theta^4+2\alpha\theta^2-125\bar{c}\phi^2-20\bar{c}\phi\theta^2}{125\phi^2+5\phi\theta^2-5\phi-2\theta^4-2\theta^2} \\ c_2^L &= -\frac{15\alpha\phi\theta^2+5\alpha\phi+2\alpha\theta^4+2\alpha\theta^2-125\bar{c}\phi^2-20\bar{c}\phi\theta^2}{125\phi^2+5\phi\theta^2-5\phi-2\theta^4-2\theta^2} \\ c_3^L &= -\frac{25\alpha\phi\theta^2+5\alpha\phi+2\alpha\theta^4+2\alpha\theta^2-125\bar{c}\phi^2-30\bar{c}\phi\theta^2}{125\phi^2+5\phi\theta^2-5\phi-2\theta^4-2\theta^2} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi+2\theta^2\right)}{125\phi^2+5\phi\theta^2-5\phi-2\theta^4-2\theta^2} \\ q_1^L &= \frac{25\phi^2(\alpha-\bar{c})}{125\phi^2+5\phi\theta^2-5\phi-2\theta^4-2\theta^2} \\ q_2^L &= \frac{25\phi^2(\alpha-\bar{c})}{125\phi^2+5\phi\theta^2-5\phi-2\theta^4-2\theta^2} \\ q_3^L &= \frac{5\phi(\alpha-\bar{c})\left(5\phi+2\theta^2\right)}{125\phi^2+5\phi\theta^2-5\phi-2\theta^4-2\theta^2} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi+2\theta^2\right)^2\cdot(25\phi-1)}{(125\phi^2+5\phi\theta^2-5\phi-2\theta^4-2\theta^2)^2} \\ \pi_1^L &= \frac{25\phi^3(\alpha-\bar{c})^2\cdot\left(25\phi-4\theta^2\right)}{(125\phi^2+5\phi\theta^2-5\phi-2\theta^4-2\theta^2)^2} \\ \pi_2^L &= \frac{25\phi^3(\alpha-\bar{c})^2\cdot\left(25\phi-4\theta^2\right)}{(125\phi^2+5\phi\theta^2-5\phi-2\theta^4-2\theta^2)^2} \\ \pi_3^L &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi+2\theta^2\right)^2\cdot\left(25\phi-\theta^2\right)}{(125\phi^2+5\phi\theta^2-5\phi-2\theta^4-2\theta^2)^2} \end{cases} \tag{49}$$

Total Production:

$$\frac{20\phi\left(\alpha-\bar{c}\right)\left(5\phi+\theta^2\right)}{125\phi^2+5\phi\theta^2-5\phi-2\theta^4-2\theta^2}$$

Price:

$$\frac{25\alpha\phi^2-15\alpha\phi\theta^2-5\alpha\phi-2\alpha\theta^4-2\alpha\theta^2+100\bar{c}\phi^2+20\bar{c}\phi\theta^2}{125\phi^2+5\phi\theta^2-5\phi-2\theta^4-2\theta^2}$$

Firm Surplus:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(2500\phi^3+775\phi^2\theta^2-25\phi^2+180\phi\theta^4-20\phi\theta^2-4\theta^6-4\theta^4\right)}{\left(125\phi^2+5\phi\theta^2-5\phi-2\theta^4-2\theta^2\right)^2}$$

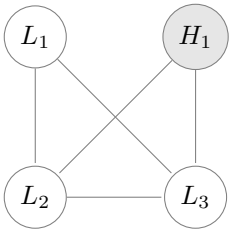
Consumer Surplus:

$$\frac{200\phi^2\left(\alpha-\bar{c}\right)^2\left(5\phi+\theta^2\right)^2}{\left(125\phi^2+5\phi\theta^2-5\phi-2\theta^4-2\theta^2\right)^2}$$

Social Welfare:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(7500\phi^3+2775\phi^2\theta^2-25\phi^2+380\phi\theta^4-20\phi\theta^2-4\theta^6-4\theta^4\right)}{\left(125\phi^2+5\phi\theta^2-5\phi-2\theta^4-2\theta^2\right)^2}$$

D.1.19 E5B [1H3L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{2}-2\right)=\alpha-3e_1^L\theta+e_2^L\theta+e_3^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right)=\alpha-3e_1^H+e_2^L\theta+e_3^L\theta-\bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{\theta}-\theta\right)=\alpha+2e_1^H+2e_1^L\theta+e_3^L\theta-\bar{c} \\ e_3^L\cdot\left(\frac{25\phi}{\theta}-\theta\right)=\alpha+2e_1^H+2e_1^L\theta+e_2^L\theta-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{10\phi(\alpha-\bar{c})\left(5\phi-2\theta^2\right)}{625\phi^3-150\phi^2\theta^2-100\phi^2-20\phi\theta^2+8\theta^4} \\ e_1^L &= \frac{10\phi\theta(\alpha-\bar{c})(5\phi-2)}{625\phi^3-150\phi^2\theta^2-100\phi^2-20\phi\theta^2+8\theta^4} \\ e_2^L &= \frac{\theta(\alpha-\bar{c})(5\phi-2\theta)(5\phi+2\theta)}{625\phi^3-150\phi^2\theta^2-100\phi^2-20\phi\theta^2+8\theta^4} \\ e_3^L &= \frac{\theta(\alpha-\bar{c})(5\phi-2\theta)(5\phi+2\theta)}{625\phi^3-150\phi^2\theta^2-100\phi^2-20\phi\theta^2+8\theta^4} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{50\alpha\phi^2\theta^2+50\alpha\phi^2-20\alpha\phi\theta^2-8\alpha\theta^4-625\bar{c}\phi^3+100\bar{c}\phi^2\theta^2+50\bar{c}\phi^2+40\bar{c}\phi\theta^2}{625\phi^3-150\phi^2\theta^2-100\phi^2-20\phi\theta^2+8\theta^4} \\ c_1^L &= -\frac{100\alpha\phi^2\theta^2-20\alpha\phi\theta^2-8\alpha\theta^4-625\bar{c}\phi^3+50\bar{c}\phi^2\theta^2+100\bar{c}\phi^2+40\bar{c}\phi\theta^2}{625\phi^3-150\phi^2\theta^2-100\phi^2-20\phi\theta^2+8\theta^4} \\ c_2^L &= -\frac{100\alpha\phi^2\theta^2+50\alpha\phi^2-40\alpha\phi\theta^2-8\alpha\theta^4-625\bar{c}\phi^3+50\bar{c}\phi^2\theta^2+50\bar{c}\phi^2+60\bar{c}\phi\theta^2}{625\phi^3-150\phi^2\theta^2-100\phi^2-20\phi\theta^2+8\theta^4} \\ c_3^L &= -\frac{100\alpha\phi^2\theta^2+50\alpha\phi^2-40\alpha\phi\theta^2-8\alpha\theta^4-625\bar{c}\phi^3+50\bar{c}\phi^2\theta^2+50\bar{c}\phi^2+60\bar{c}\phi\theta^2}{625\phi^3-150\phi^2\theta^2-100\phi^2-20\phi\theta^2+8\theta^4} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{25\phi^2(\alpha-\bar{c})\left(5\phi-2\theta^2\right)}{625\phi^3-150\phi^2\theta^2-100\phi^2-20\phi\theta^2+8\theta^4} \\ q_1^L &= \frac{25\phi^2(\alpha-\bar{c})(5\phi-2)}{625\phi^3-150\phi^2\theta^2-100\phi^2-20\phi\theta^2+8\theta^4} \\ q_2^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-2\theta)(5\phi+2\theta)}{625\phi^3-150\phi^2\theta^2-100\phi^2-20\phi\theta^2+8\theta^4} \\ q_3^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-2\theta)(5\phi+2\theta)}{625\phi^3-150\phi^2\theta^2-100\phi^2-20\phi\theta^2+8\theta^4} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{25\phi^3(\alpha-\bar{c})^2\left(5\phi-2\theta^2\right)^2\cdot(25\phi-4)}{(625\phi^3-150\phi^2\theta^2-100\phi^2-20\phi\theta^2+8\theta^4)^2} \\ \pi_1^L &= \frac{25\phi^3(\alpha-\bar{c})^2(5\phi-2)^2\cdot\left(25\phi-4\theta^2\right)}{(625\phi^3-150\phi^2\theta^2-100\phi^2-20\phi\theta^2+8\theta^4)^2} \\ \pi_2^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-2\theta)^2(5\phi+2\theta)^2\cdot\left(25\phi-\theta^2\right)}{(625\phi^3-150\phi^2\theta^2-100\phi^2-20\phi\theta^2+8\theta^4)^2} \\ \pi_3^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-2\theta)^2(5\phi+2\theta)^2\cdot\left(25\phi-\theta^2\right)}{(625\phi^3-150\phi^2\theta^2-100\phi^2-20\phi\theta^2+8\theta^4)^2} \end{cases} \tag{50}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(50\phi^2-5\phi\theta^2-5\phi-4\theta^2\right)}{625\phi^3-150\phi^2\theta^2-100\phi^2-20\phi\theta^2+8\theta^4}$$

Price:

$$\frac{125\alpha\phi^3-100\alpha\phi^2\theta^2-50\alpha\phi^2+20\alpha\phi\theta^2+8\alpha\theta^4+500\bar{c}\phi^3-50\bar{c}\phi^2\theta^2-50\bar{c}\phi^2-40\bar{c}\phi\theta^2}{625\phi^3-150\phi^2\theta^2-100\phi^2-20\phi\theta^2+8\theta^4}$$

Firm Surplus:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(31250\phi^5-8125\phi^4\theta^2-7500\phi^4+1250\phi^3\theta^4-3000\phi^3\theta^2+1250\phi^3-200\phi^2\theta^2+400\phi\theta^4-16\theta^6\right)}{\left(625\phi^3-150\phi^2\theta^2-100\phi^2-20\phi\theta^2+8\theta^4\right)^2}$$

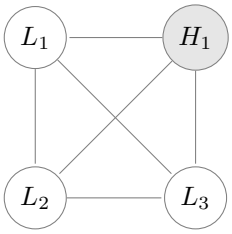
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(50\phi^2-5\phi\theta^2-5\phi-4\theta^2\right)^2}{\left(625\phi^3-150\phi^2\theta^2-100\phi^2-20\phi\theta^2+8\theta^4\right)^2}$$

Social Welfare:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(93750\phi^5-20625\phi^4\theta^2-20000\phi^4+1875\phi^3\theta^4-11750\phi^3\theta^2+1875\phi^3+1000\phi^2\theta^4+800\phi^2\theta^2+800\phi\theta^4-16\theta^6\right)}{\left(625\phi^3-150\phi^2\theta^2-100\phi^2-20\phi\theta^2+8\theta^4\right)^2}$$

D.1.20 E6A [1H3L]



$$Equations: \begin{cases} e_1^H\cdot(25\phi-1) = \alpha+e_1^L\theta+e_2^L\theta+e_3^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{\theta}-\theta\right) = \alpha+e_1^H+e_2^L\theta+e_3^L\theta-\bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{\theta}-\theta\right) = \alpha+e_1^H+e_1^L\theta+e_3^L\theta-\bar{c} \\ e_3^L\cdot\left(\frac{25\phi}{\theta}-\theta\right) = \alpha+e_1^H+e_1^L\theta+e_2^L\theta-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{\alpha-\bar{c}}{25\phi-3\theta^2-1} \\ e_1^L &= \frac{\theta(\alpha-\bar{c})}{25\phi-3\theta^2-1} \\ e_2^L &= \frac{\theta(\alpha-\bar{c})}{25\phi-3\theta^2-1} \\ e_3^L &= \frac{\theta(\alpha-\bar{c})}{25\phi-3\theta^2-1} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{3\alpha\theta^2+\alpha-25\bar{c}\phi}{25\phi-3\theta^2-1} \\ c_1^L &= -\frac{3\alpha\theta^2+\alpha-25\bar{c}\phi}{25\phi-3\theta^2-1} \\ c_2^L &= -\frac{3\alpha\theta^2+\alpha-25\bar{c}\phi}{25\phi-3\theta^2-1} \\ c_3^L &= -\frac{3\alpha\theta^2+\alpha-25\bar{c}\phi}{25\phi-3\theta^2-1} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})}{25\phi-3\theta^2-1} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})}{25\phi-3\theta^2-1} \\ q_2^L &= \frac{5\phi(\alpha-\bar{c})}{25\phi-3\theta^2-1} \\ q_3^L &= \frac{5\phi(\alpha-\bar{c})}{25\phi-3\theta^2-1} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\cdot(25\phi-1)}{(25\phi-3\theta^2-1)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2\cdot\left(25\phi-\theta^2\right)}{(25\phi-3\theta^2-1)^2} \\ \pi_2^L &= \frac{\phi(\alpha-\bar{c})^2\cdot\left(25\phi-\theta^2\right)}{(25\phi-3\theta^2-1)^2} \\ \pi_3^L &= \frac{\phi(\alpha-\bar{c})^2\cdot\left(25\phi-\theta^2\right)}{(25\phi-3\theta^2-1)^2} \end{cases} \tag{51}$$

Total Production:

$$\frac{20\phi\left(\alpha-\bar{c}\right)}{25\phi-3\theta^2-1}$$

Price:

$$\frac{5\alpha\phi-3\alpha\theta^2-\alpha+20\bar{c}\phi}{25\phi-3\theta^2-1}$$

Firm Surplus:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(100\phi-3\theta^2-1\right)}{\left(25\phi-3\theta^2-1\right)^2}$$

Consumer Surplus:

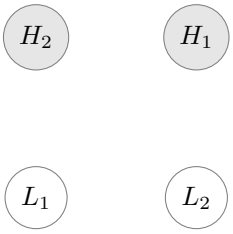
$$\frac{200\phi^2\left(\alpha-\bar{c}\right)^2}{\left(25\phi-3\theta^2-1\right)^2}$$

Social Welfare:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(300\phi-3\theta^2-1\right)}{\left(25\phi-3\theta^2-1\right)^2}$$

D.2 Two *high*- and two *low*-productive firms ($2H2L$)

D.2.1 E0A [2H2L]



$$Equations: \begin{cases} e_1^H \cdot \left(\frac{25\phi}{4} - 4\right) = \alpha - e_2^H - e_1^L\theta - e_2^L\theta - \bar{c} \\ e_2^H \cdot \left(\frac{25\phi}{4} - 4\right) = \alpha - e_1^H - e_1^L\theta - e_2^L\theta - \bar{c} \\ e_1^L \cdot \left(\frac{25\phi}{4\theta} - 4\theta\right) = \alpha - e_1^H - e_2^H - e_2^L\theta - \bar{c} \\ e_2^L \cdot \left(\frac{25\phi}{4\theta} - 4\theta\right) = \alpha - e_1^H - e_2^H - e_1^L\theta - \bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{4(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-60\phi\theta^2-60\phi+16\theta^2} \\ e_2^H &= \frac{4(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-60\phi\theta^2-60\phi+16\theta^2} \\ e_1^L &= \frac{4\theta(\alpha-\bar{c})(5\phi-4)}{125\phi^2-60\phi\theta^2-60\phi+16\theta^2} \\ e_2^L &= \frac{4\theta(\alpha-\bar{c})(5\phi-4)}{125\phi^2-60\phi\theta^2-60\phi+16\theta^2} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{20\alpha\phi-16\alpha\theta^2-125\bar{c}\phi^2+60\bar{c}\phi\theta^2+40\bar{c}\phi}{125\phi^2-60\phi\theta^2-60\phi+16\theta^2} \\ c_2^H &= -\frac{20\alpha\phi-16\alpha\theta^2-125\bar{c}\phi^2+60\bar{c}\phi\theta^2+40\bar{c}\phi}{125\phi^2-60\phi\theta^2-60\phi+16\theta^2} \\ c_1^L &= -\frac{20\alpha\phi\theta^2-16\alpha\theta^2-125\bar{c}\phi^2+40\bar{c}\phi\theta^2+60\bar{c}\phi}{125\phi^2-60\phi\theta^2-60\phi+16\theta^2} \\ c_2^L &= -\frac{20\alpha\phi\theta^2-16\alpha\theta^2-125\bar{c}\phi^2+40\bar{c}\phi\theta^2+60\bar{c}\phi}{125\phi^2-60\phi\theta^2-60\phi+16\theta^2} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-60\phi\theta^2-60\phi+16\theta^2} \\ q_2^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-60\phi\theta^2-60\phi+16\theta^2} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-4)}{125\phi^2-60\phi\theta^2-60\phi+16\theta^2} \\ q_2^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-4)}{125\phi^2-60\phi\theta^2-60\phi+16\theta^2} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-4\theta^2\right)^2\cdot(25\phi-16)}{(125\phi^2-60\phi\theta^2-60\phi+16\theta^2)^2} \\ \pi_2^H &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-4\theta^2\right)^2\cdot(25\phi-16)}{(125\phi^2-60\phi\theta^2-60\phi+16\theta^2)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-4)^2\cdot\left(25\phi-16\theta^2\right)}{(125\phi^2-60\phi\theta^2-60\phi+16\theta^2)^2} \\ \pi_2^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-4)^2\cdot\left(25\phi-16\theta^2\right)}{(125\phi^2-60\phi\theta^2-60\phi+16\theta^2)^2} \end{cases} \tag{52}$$

Total Production:

$$\frac{20\phi\left(\alpha-\bar{c}\right)\left(5\phi-2\theta^2-2\right)}{125\phi^2-60\phi\theta^2-60\phi+16\theta^2}$$

Price:

$$\frac{25\alpha\phi^2-20\alpha\phi\theta^2-20\alpha\phi+16\alpha\theta^2+100\bar{c}\phi^2-40\bar{c}\phi\theta^2-40\bar{c}\phi}{125\phi^2-60\phi\theta^2-60\phi+16\theta^2}$$

Firm Surplus:

$$\frac{4\phi\left(\alpha-\bar{c}\right)^2\cdot\left(625\phi^3-700\phi^2\theta^2-700\phi^2+200\phi\theta^4+640\phi\theta^2+200\phi-128\theta^4-128\theta^2\right)}{\left(125\phi^2-60\phi\theta^2-60\phi+16\theta^2\right)^2}$$

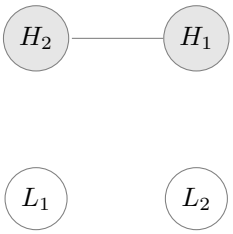
Consumer Surplus:

$$\frac{200\phi^2\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2-2\right)^2}{\left(125\phi^2-60\phi\theta^2-60\phi+16\theta^2\right)^2}$$

Social Welfare:

$$\frac{4\phi\left(\alpha-\bar{c}\right)^2\cdot\left(1875\phi^3-1700\phi^2\theta^2-1700\phi^2+400\phi\theta^4+1040\phi\theta^2+400\phi-128\theta^4-128\theta^2\right)}{\left(125\phi^2-60\phi\theta^2-60\phi+16\theta^2\right)^2}$$

D.2.2 E1A [2H2L]



$$Equations:\begin{cases}e_1^H\cdot\left(\frac{25\phi}{3}-3\right)=\alpha+3e_2^H-e_1^L\theta-e_2^L\theta-\bar{c}\\ e_2^H\cdot\left(\frac{25\phi}{3}-3\right)=\alpha+3e_1^H-e_1^L\theta-e_2^L\theta-\bar{c}\\ e_1^L\cdot\left(\frac{25\phi}{4\theta}-4\theta\right)=\alpha-2e_1^H-2e_2^H-e_2^L\theta-\bar{c}\\ e_2^L\cdot\left(\frac{25\phi}{4\theta}-4\theta\right)=\alpha-2e_1^H-2e_2^H-e_1^L\theta-\bar{c}\end{cases}$$

Optimal efforts:

$$\begin{cases}e_1^H &= \frac{3(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-60\phi\theta^2-90\phi+24\theta^2}\\ e_2^H &= \frac{3(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-60\phi\theta^2-90\phi+24\theta^2}\\ e_1^L &= \frac{4\theta(\alpha-\bar{c})(5\phi-6)}{125\phi^2-60\phi\theta^2-90\phi+24\theta^2}\\ e_2^L &= \frac{4\theta(\alpha-\bar{c})(5\phi-6)}{125\phi^2-60\phi\theta^2-90\phi+24\theta^2}\end{cases}$$

Production Costs:

$$\begin{cases}c_1^H &= -\frac{30\alpha\phi-24\alpha\theta^2-125\bar{c}\phi^2+60\bar{c}\phi\theta^2+60\bar{c}\phi}{125\phi^2-60\phi\theta^2-90\phi+24\theta^2}\\ c_2^H &= -\frac{30\alpha\phi-24\alpha\theta^2-125\bar{c}\phi^2+60\bar{c}\phi\theta^2+60\bar{c}\phi}{125\phi^2-60\phi\theta^2-90\phi+24\theta^2}\\ c_1^L &= -\frac{20\alpha\phi\theta^2-24\alpha\theta^2-125\bar{c}\phi^2+40\bar{c}\phi\theta^2+90\bar{c}\phi}{125\phi^2-60\phi\theta^2-90\phi+24\theta^2}\\ c_2^L &= -\frac{20\alpha\phi\theta^2-24\alpha\theta^2-125\bar{c}\phi^2+40\bar{c}\phi\theta^2+90\bar{c}\phi}{125\phi^2-60\phi\theta^2-90\phi+24\theta^2}\end{cases}$$

Production Quantities:

$$\begin{cases}q_1^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-60\phi\theta^2-90\phi+24\theta^2}\\ q_2^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-60\phi\theta^2-90\phi+24\theta^2}\\ q_1^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-6)}{125\phi^2-60\phi\theta^2-90\phi+24\theta^2}\\ q_2^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-6)}{125\phi^2-60\phi\theta^2-90\phi+24\theta^2}\end{cases}$$

Profits:

$$\begin{cases}\pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-4\theta^2\right)^2\cdot(25\phi-9)}{(125\phi^2-60\phi\theta^2-90\phi+24\theta^2)^2}\\ \pi_2^H &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-4\theta^2\right)^2\cdot(25\phi-9)}{(125\phi^2-60\phi\theta^2-90\phi+24\theta^2)^2}\\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-6)^2\cdot\left(25\phi-16\theta^2\right)}{(125\phi^2-60\phi\theta^2-90\phi+24\theta^2)^2}\\ \pi_2^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-6)^2\cdot\left(25\phi-16\theta^2\right)}{(125\phi^2-60\phi\theta^2-90\phi+24\theta^2)^2}\end{cases}\tag{53}$$

Total Production:

$$\frac{20\phi\left(\alpha-\bar{c}\right)\left(5\phi-2\theta^2-3\right)}{125\phi^2-60\phi\theta^2-90\phi+24\theta^2}$$

Price:

$$\frac{25\alpha\phi^2-20\alpha\phi\theta^2-30\alpha\phi+24\alpha\theta^2+100\bar{c}\phi^2-40\bar{c}\phi\theta^2-60\bar{c}\phi}{125\phi^2-60\phi\theta^2-90\phi+24\theta^2}$$

Firm Surplus:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(1250\phi^3-1400\phi^2\theta^2-1725\phi^2+400\phi\theta^4+1320\phi\theta^2+900\phi-144\theta^4-576\theta^2\right)}{\left(125\phi^2-60\phi\theta^2-90\phi+24\theta^2\right)^2}$$

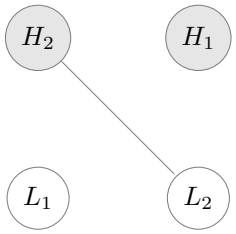
Consumer Surplus:

$$\frac{200\phi^2\left(\alpha-\bar{c}\right)^2\left(5\phi-2\theta^2-3\right)^2}{\left(125\phi^2-60\phi\theta^2-90\phi+24\theta^2\right)^2}$$

Social Welfare:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(3750\phi^3-3400\phi^2\theta^2-4725\phi^2+800\phi\theta^4+2520\phi\theta^2+1800\phi-144\theta^4-576\theta^2\right)}{\left(125\phi^2-60\phi\theta^2-90\phi+24\theta^2\right)^2}$$

D.2.3 E1B [2H2L]



$$Equations:\begin{cases}e_1^H\cdot\left(\frac{25\phi}{4}-4\right)=\alpha-2e_2^H-e_1^L\theta-2e_2^L\theta-\bar{c}\\ e_2^H\cdot\left(\frac{25\phi}{3}-3\right)=\alpha-e_1^H-e_1^L\theta+3e_2^L\theta-\bar{c}\\ e_1^L\cdot\left(\frac{25\phi}{4\theta}-4\theta\right)=\alpha-e_1^H-2e_2^H-2e_2^L\theta-\bar{c}\\ e_2^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right)=\alpha-e_1^H+3e_2^H-e_1^L\theta-\bar{c}\end{cases}$$

Optimal efforts:

$$\begin{cases}e_1^H &= \frac{4(\alpha-\bar{c})\left(5\phi-4\theta^2\right)\left(5\phi-3\theta^2-3\right)}{625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2}\\ e_2^H &= \frac{3(\alpha-\bar{c})(5\phi-4)\left(5\phi-4\theta^2\right)}{625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2}\\ e_1^L &= \frac{4\theta(\alpha-\bar{c})(5\phi-4)\left(5\phi-3\theta^2-3\right)}{625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2}\\ e_2^L &= \frac{3\theta(\alpha-\bar{c})(5\phi-4)\left(5\phi-4\theta^2\right)}{625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2}\end{cases}$$

Production Costs:

$$\begin{cases}c_1^H &= -\frac{100\alpha\phi^2-140\alpha\phi\theta^2-60\alpha\phi+48\alpha\theta^4+48\alpha\theta^2-625\bar{c}\phi^3+625\bar{c}\phi^2\theta^2+525\bar{c}\phi^2-120\bar{c}\phi\theta^4-340\bar{c}\phi\theta^2-60\bar{c}\phi}{625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2}\\ c_2^H &= -\frac{75\alpha\phi^2\theta^2+75\alpha\phi^2-60\alpha\phi\theta^4-120\alpha\phi\theta^2-60\alpha\phi+48\alpha\theta^4+48\alpha\theta^2-625\bar{c}\phi^3+550\bar{c}\phi^2\theta^2+550\bar{c}\phi^2-60\bar{c}\phi\theta^4-360\bar{c}\phi\theta^2-60\bar{c}\phi}{625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2}\\ c_1^L &= -\frac{100\alpha\phi^2\theta^2-60\alpha\phi\theta^4-140\alpha\phi\theta^2+48\alpha\theta^4+48\alpha\theta^2-625\bar{c}\phi^3+525\bar{c}\phi^2\theta^2+625\bar{c}\phi^2-60\bar{c}\phi\theta^4-340\bar{c}\phi\theta^2-120\bar{c}\phi}{625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2}\\ c_2^L &= -\frac{75\alpha\phi^2\theta^2+75\alpha\phi^2-60\alpha\phi\theta^4-120\alpha\phi\theta^2-60\alpha\phi+48\alpha\theta^4+48\alpha\theta^2-625\bar{c}\phi^3+550\bar{c}\phi^2\theta^2+550\bar{c}\phi^2-60\bar{c}\phi\theta^4-360\bar{c}\phi\theta^2-60\bar{c}\phi}{625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2}\end{cases}$$

Production Quantities:

$$\begin{cases}q_1^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-4\theta^2\right)\left(5\phi-3\theta^2-3\right)}{625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2}\\ q_2^H &= \frac{5\phi(\alpha-\bar{c})(5\phi-4)\left(5\phi-4\theta^2\right)}{625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2}\\ q_1^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-4)\left(5\phi-3\theta^2-3\right)}{625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2}\\ q_2^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-4)\left(5\phi-4\theta^2\right)}{625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2}\end{cases}$$

Profits:

$$\begin{cases}\pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-4\theta^2\right)^2\cdot(25\phi-16)\left(5\phi-3\theta^2-3\right)^2}{(625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2)^2}\\ \pi_2^H &= \frac{\phi(\alpha-\bar{c})^2(5\phi-4)^2\left(5\phi-4\theta^2\right)^2\cdot(25\phi-9)}{(625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2)^2}\\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-4)^2\cdot\left(25\phi-16\theta^2\right)\left(5\phi-3\theta^2-3\right)^2}{(625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2)^2}\\ \pi_2^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-4)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{(625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2)^2}\end{cases}\tag{54}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(50\phi^2-45\phi\theta^2-45\phi+6\theta^4+28\theta^2+6\right)}{625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2}$$

Price:

$$\frac{125\alpha\phi^3-175\alpha\phi^2\theta^2-175\alpha\phi^2+60\alpha\phi\theta^4+200\alpha\phi\theta^2+60\alpha\phi-48\alpha\theta^4-48\alpha\theta^2+500\bar{c}\phi^3-450\bar{c}\phi^2\theta^2-450\bar{c}\phi^2+60\bar{c}\phi\theta^4+280\bar{c}\phi\theta^2+60\bar{c}\phi}{625\phi^3-625\phi^2\theta^2-625\phi^2+120\phi\theta^4+480\phi\theta^2+120\phi-48\theta^4-48\theta^2}$$

Firm Surplus:

$$\frac{\phi\left(\alpha-\bar{c}\right)^{2}\cdot\left(62500\phi^{5}-128125\phi^{4}\theta^{2}-128125\phi^{4}+92250\phi^{3}\theta^{4}+236500\phi^{3}\theta^{2}+92250\phi^{3}-28200\phi^{2}\theta^{6}-144600\phi^{2}\theta^{4}-144600\phi^{2}\theta^{2}-28200\phi^{2}+3600\phi\theta^{8}+32160\phi\theta^{6}+69920\phi\theta^{4}+32160\phi\theta^{2}+3600\phi-2304\theta^{8}-9216\theta^{6}-9216\theta^{4}-2304\theta^{2}\right)}{\left(625\phi^{3}-625\phi^{2}\theta^{2}-625\phi^{2}+120\phi\theta^{4}+480\phi\theta^{2}+120\phi-48\theta^{4}-48\theta^{2}\right)^{2}}$$

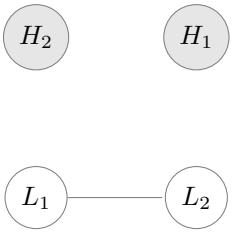
Consumer Surplus:

$$\frac{50\phi^{2}\left(\alpha-\bar{c}\right)^{2}\left(50\phi^{2}-45\phi\theta^{2}-45\phi+6\theta^{4}+28\theta^{2}+6\right)^{2}}{\left(625\phi^{3}-625\phi^{2}\theta^{2}-625\phi^{2}+120\phi\theta^{4}+480\phi\theta^{2}+120\phi-48\theta^{4}-48\theta^{2}\right)^{2}}$$

Social Welfare:

$$\frac{\phi\left(\alpha-\bar{c}\right)^{2}\cdot\left(187500\phi^{5}-353125\phi^{4}\theta^{2}-353125\phi^{4}+223500\phi^{3}\theta^{4}+579000\phi^{3}\theta^{2}+223500\phi^{3}-55200\phi^{2}\theta^{6}-297600\phi^{2}\theta^{4}-297600\phi^{2}\theta^{2}-55200\phi^{2}+5400\phi\theta^{8}+48960\phi\theta^{6}+112720\phi\theta^{4}+48960\phi\theta^{2}+5400\phi-2304\theta^{8}-9216\theta^{6}-9216\theta^{4}-2304\theta^{2}\right)}{\left(625\phi^{3}-625\phi^{2}\theta^{2}-625\phi^{2}+120\phi\theta^{4}+480\phi\theta^{2}+120\phi-48\theta^{4}-48\theta^{2}\right)^{2}}$$

D.2.4 E1C [2H2L]



$$Equations:\begin{cases} e_1^H\cdot\left(\frac{25\phi}{4}-4\right)=\alpha-e_2^H-2e_1^L\theta-2e_2^L\theta-\bar{c}\\ e_2^H\cdot\left(\frac{25\phi}{4}-4\right)=\alpha-e_1^H-2e_1^L\theta-2e_2^L\theta-\bar{c}\\ e_1^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right)=\alpha-e_1^H-e_2^H+3e_2^L\theta-\bar{c}\\ e_2^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right)=\alpha-e_1^H-e_2^H+3e_1^L\theta-\bar{c}\end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{4(\alpha-\bar{c})\left(5\phi-6\theta^2\right)}{125\phi^2-90\phi\theta^2-60\phi+24\theta^2}\\ e_2^H &= \frac{4(\alpha-\bar{c})\left(5\phi-6\theta^2\right)}{125\phi^2-90\phi\theta^2-60\phi+24\theta^2}\\ e_1^L &= \frac{3\theta(\alpha-\bar{c})(5\phi-4)}{125\phi^2-90\phi\theta^2-60\phi+24\theta^2}\\ e_2^L &= \frac{3\theta(\alpha-\bar{c})(5\phi-4)}{125\phi^2-90\phi\theta^2-60\phi+24\theta^2}\end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{20\alpha\phi-24\alpha\theta^2-125\bar{c}\phi^2+90\bar{c}\phi\theta^2+40\bar{c}\phi}{125\phi^2-90\phi\theta^2-60\phi+24\theta^2}\\ c_2^H &= -\frac{20\alpha\phi-24\alpha\theta^2-125\bar{c}\phi^2+90\bar{c}\phi\theta^2+40\bar{c}\phi}{125\phi^2-90\phi\theta^2-60\phi+24\theta^2}\\ c_1^L &= -\frac{30\alpha\phi\theta^2-24\alpha\theta^2-125\bar{c}\phi^2+60\bar{c}\phi\theta^2+60\bar{c}\phi}{125\phi^2-90\phi\theta^2-60\phi+24\theta^2}\\ c_2^L &= -\frac{30\alpha\phi\theta^2-24\alpha\theta^2-125\bar{c}\phi^2+60\bar{c}\phi\theta^2+60\bar{c}\phi}{125\phi^2-90\phi\theta^2-60\phi+24\theta^2}\end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-6\theta^2\right)}{125\phi^2-90\phi\theta^2-60\phi+24\theta^2}\\ q_2^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-6\theta^2\right)}{125\phi^2-90\phi\theta^2-60\phi+24\theta^2}\\ q_1^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-4)}{125\phi^2-90\phi\theta^2-60\phi+24\theta^2}\\ q_2^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-4)}{125\phi^2-90\phi\theta^2-60\phi+24\theta^2}\end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-6\theta^2\right)^2\cdot(25\phi-16)}{(125\phi^2-90\phi\theta^2-60\phi+24\theta^2)^2}\\ \pi_2^H &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-6\theta^2\right)^2\cdot(25\phi-16)}{(125\phi^2-90\phi\theta^2-60\phi+24\theta^2)^2}\\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-4)^2\cdot\left(25\phi-9\theta^2\right)}{(125\phi^2-90\phi\theta^2-60\phi+24\theta^2)^2}\\ \pi_2^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-4)^2\cdot\left(25\phi-9\theta^2\right)}{(125\phi^2-90\phi\theta^2-60\phi+24\theta^2)^2}\end{cases} \tag{55}$$

Total Production:

$$\frac{20\phi\left(\alpha-\bar{c}\right)\left(5\phi-3\theta^{2}-2\right)}{125\phi^{2}-90\phi\theta^{2}-60\phi+24\theta^{2}}$$

Price:

$$\frac{25\alpha\phi^{2}-30\alpha\phi\theta^{2}-20\alpha\phi+24\alpha\theta^{2}+100\bar{c}\phi^{2}-60\bar{c}\phi\theta^{2}-40\bar{c}\phi}{125\phi^{2}-90\phi\theta^{2}-60\phi+24\theta^{2}}$$

Firm Surplus:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(1250\phi^3-1725\phi^2\theta^2-1400\phi^2+900\phi\theta^4+1320\phi\theta^2+400\phi-576\theta^4-144\theta^2\right)}{\left(125\phi^2-90\phi\theta^2-60\phi+24\theta^2\right)^2}$$

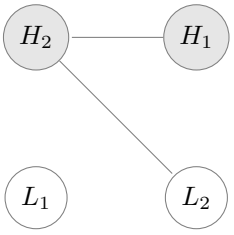
Consumer Surplus:

$$\frac{200\phi^2\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2-2\right)^2}{\left(125\phi^2-90\phi\theta^2-60\phi+24\theta^2\right)^2}$$

Social Welfare:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(3750\phi^3-4725\phi^2\theta^2-3400\phi^2+1800\phi\theta^4+2520\phi\theta^2+800\phi-576\theta^4-144\theta^2\right)}{\left(125\phi^2-90\phi\theta^2-60\phi+24\theta^2\right)^2}$$

D.2.5 E2A [2H2L]



$$Equations:\begin{cases}e_1^H\cdot\left(\frac{25\phi}{3}-3\right)=\alpha+2e_2^H-e_1^L\theta-2e_2^L\theta-\bar{c}\\ e_2^H\cdot\left(\frac{25\phi}{2}-2\right)=\alpha+3e_1^H-e_1^L\theta+3e_2^L\theta-\bar{c}\\ e_1^L\cdot\left(\frac{25\phi}{4\theta}-4\theta\right)=\alpha-2e_1^H-3e_2^H-2e_2^L\theta-\bar{c}\\ e_2^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right)=\alpha-2e_1^H+2e_2^H-e_1^L\theta-\bar{c}\end{cases}$$

Optimal efforts:

$$\begin{cases}e_1^H &= \frac{15\phi(\alpha-\bar{c})\left(5\phi-4\theta^2\right)\left(5\phi-3\theta^2\right)}{3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4}\\ e_2^H &= \frac{2(\alpha-\bar{c})(5\phi-3\theta)(5\phi+3\theta)\left(5\phi-4\theta^2\right)}{3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4}\\ e_1^L &= \frac{4\theta(\alpha-\bar{c})\left(125\phi^3-75\phi^2\theta^2-125\phi^2+45\phi\theta^2+18\theta^2\right)}{3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4}\\ e_2^L &= \frac{15\phi\theta(\alpha-\bar{c})(5\phi-3)\left(5\phi-4\theta^2\right)}{3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4}\end{cases}$$

Production Costs:

$$\begin{cases}c_1^H &= -\frac{625\alpha\phi^3-725\alpha\phi^2\theta^2+180\alpha\phi\theta^4-90\alpha\phi\theta^2+72\alpha\theta^4-3125\bar{c}\phi^4+3125\bar{c}\phi^3\theta^2+1000\bar{c}\phi^3-600\bar{c}\phi^2\theta^4-300\bar{c}\phi^2\theta^2-180\bar{c}\phi\theta^4-90\bar{c}\phi\theta^2}{3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4}\\ c_2^H &= -\frac{375\alpha\phi^3\theta^2+625\alpha\phi^3-300\alpha\phi^2\theta^4-950\alpha\phi^2\theta^2+360\alpha\phi\theta^4-90\alpha\phi\theta^2+72\alpha\theta^4-3125\bar{c}\phi^4+2750\bar{c}\phi^3\theta^2+1000\bar{c}\phi^3-300\bar{c}\phi^2\theta^4-75\bar{c}\phi^2\theta^2-360\bar{c}\phi\theta^4-90\bar{c}\phi\theta^2}{3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4}\\ c_1^L &= -\frac{500\alpha\phi^3\theta^2-300\alpha\phi^2\theta^4-500\alpha\phi^2\theta^2+180\alpha\phi\theta^4+72\alpha\theta^4-3125\bar{c}\phi^4+2625\bar{c}\phi^3\theta^2+1625\bar{c}\phi^3-300\bar{c}\phi^2\theta^4-525\bar{c}\phi^2\theta^2-180\bar{c}\phi\theta^4-180\bar{c}\phi\theta^2}{3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4}\\ c_2^L &= -\frac{375\alpha\phi^3\theta^2+250\alpha\phi^3-300\alpha\phi^2\theta^4-425\alpha\phi^2\theta^2+180\alpha\phi\theta^4-90\alpha\phi\theta^2+72\alpha\theta^4-3125\bar{c}\phi^4+2750\bar{c}\phi^3\theta^2+1375\bar{c}\phi^3-300\bar{c}\phi^2\theta^4-600\bar{c}\phi^2\theta^2-180\bar{c}\phi\theta^4-90\bar{c}\phi\theta^2}{3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4}\end{cases}$$

Production Quantities:

$$\begin{cases}q_1^H &= \frac{25\phi^2(\alpha-\bar{c})\left(5\phi-4\theta^2\right)\left(5\phi-3\theta^2\right)}{3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4}\\ q_2^H &= \frac{5\phi(\alpha-\bar{c})(5\phi-3\theta)(5\phi+3\theta)\left(5\phi-4\theta^2\right)}{3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4}\\ q_1^L &= \frac{5\phi(\alpha-\bar{c})\left(125\phi^3-75\phi^2\theta^2-125\phi^2+45\phi\theta^2+18\theta^2\right)}{3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4}\\ q_2^L &= \frac{25\phi^2(\alpha-\bar{c})(5\phi-3)\left(5\phi-4\theta^2\right)}{3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4}\end{cases}$$

Profits:

$$\begin{cases}\pi_1^H &= \frac{25\phi^3(\alpha-\bar{c})^2\left(5\phi-4\theta^2\right)^2\left(5\phi-3\theta^2\right)^2\cdot(25\phi-9)}{(3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4)^2}\\ \pi_2^H &= \frac{\phi(\alpha-\bar{c})^2(5\phi-3\theta)^2(5\phi+3\theta)^2\left(5\phi-4\theta^2\right)^2\cdot(25\phi-4)}{(3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4)^2}\\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2\cdot\left(25\phi-16\theta^2\right)\left(125\phi^3-75\phi^2\theta^2-125\phi^2+45\phi\theta^2+18\theta^2\right)^2}{(3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4)^2}\\ \pi_2^L &= \frac{25\phi^3(\alpha-\bar{c})^2(5\phi-3)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-9\theta^2\right)}{(3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4)^2}\end{cases}\tag{56}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(250\phi^3-225\phi^2\theta^2-100\phi^2+30\phi\theta^4+30\phi\theta^2+18\theta^4+9\theta^2\right)}{3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4}$$

Price:

$$\frac{625\alpha\phi^4-875\alpha\phi^3\theta^2-625\alpha\phi^3+300\alpha\phi^2\theta^4+725\alpha\phi^2\theta^2-180\alpha\phi\theta^4+90\alpha\phi\theta^2-72\alpha\theta^4+2500\bar{c}\phi^4-2250\bar{c}\phi^3\theta^2-1000\bar{c}\phi^3+300\bar{c}\phi^2\theta^4+300\bar{c}\phi^2\theta^2+180\bar{c}\phi\theta^4+90\bar{c}\phi\theta^2}{3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4}$$

Firm Surplus:

$$\frac{\phi(\alpha-\bar{c})^2\cdot(1562500\phi^7-3203125\phi^6\theta^2-1453125\phi^6+2306250\phi^5\theta^4+2381250\phi^5\theta^2+531250\phi^5-705000\phi^4\theta^6-1219375\phi^4\theta^4-649375\phi^4\theta^2+90000\phi^3\theta^8+225000\phi^3\theta^6+240750\phi^3\theta^4-112500\phi^3\theta^2-32400\phi^2\theta^8-73800\phi^2\theta^6+104400\phi^2\theta^4+32400\phi\theta^8-12960\phi\theta^6+8100\phi\theta^4-5184\theta^8-5184\theta^6)}{(3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4)^2}$$

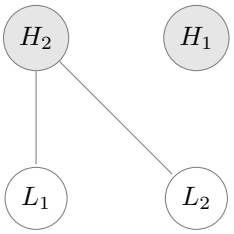
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(250\phi^3-225\phi^2\theta^2-100\phi^2+30\phi\theta^4+30\phi\theta^2+18\theta^4+9\theta^2\right)^2}{\left(3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4\right)^2}$$

Social Welfare:

$$\frac{\phi(\alpha-\bar{c})^2\cdot(4687500\phi^7-8828125\phi^6\theta^2-3953125\phi^6+5587500\phi^5\theta^4+5381250\phi^5\theta^2+1031250\phi^5-1380000\phi^4\theta^6-1744375\phi^4\theta^4-724375\phi^4\theta^2+135000\phi^3\theta^8-90000\phi^3\theta^6-96750\phi^3\theta^4-202500\phi^3\theta^2+21600\phi^2\theta^8+7200\phi^2\theta^6+131400\phi^2\theta^4+48600\phi\theta^8+3240\phi\theta^6+12150\phi\theta^4-5184\theta^8-5184\theta^6)}{(3125\phi^4-3125\phi^3\theta^2-1625\phi^3+600\phi^2\theta^4+1025\phi^2\theta^2+180\phi\theta^2-72\theta^4)^2}$$

D.2.6 E2B [2H2L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{4}-4\right)=\alpha-3e_2^H-2e_1^L\theta-2e_2^L\theta-\bar{c} \\ e_2^H\cdot\left(\frac{25\phi}{2}-2\right)=\alpha-e_1^H+3e_1^L\theta+3e_2^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right)=\alpha-e_1^H+2e_2^H-2e_2^L\theta-\bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right)=\alpha-e_1^H+2e_2^H-2e_1^L\theta-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{4(\alpha-\bar{c})\left(25\phi^2-15\phi\theta^2-10\phi-6\theta^2\right)}{625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2} \\ e_2^H &= \frac{2(\alpha-\bar{c})(5\phi-4)\left(5\phi+3\theta^2\right)}{625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2} \\ e_1^L &= \frac{15\phi\theta(\alpha-\bar{c})(5\phi-4)}{625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2} \\ e_2^L &= \frac{15\phi\theta(\alpha-\bar{c})(5\phi-4)}{625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{100\alpha\phi^2-60\alpha\phi\theta^2-40\alpha\phi-24\alpha\theta^2-625\bar{c}\phi^3+75\bar{c}\phi^2\theta^2+400\bar{c}\phi^2+120\bar{c}\phi\theta^2}{625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2} \\ c_2^H &= -\frac{150\alpha\phi^2\theta^2+50\alpha\phi^2-90\alpha\phi\theta^2-40\alpha\phi-24\alpha\theta^2-625\bar{c}\phi^3-75\bar{c}\phi^2\theta^2+450\bar{c}\phi^2+150\bar{c}\phi\theta^2}{625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2} \\ c_1^L &= -\frac{75\alpha\phi^2\theta^2+50\alpha\phi^2-30\alpha\phi\theta^2-40\alpha\phi-24\alpha\theta^2-625\bar{c}\phi^3+450\bar{c}\phi^2+90\bar{c}\phi\theta^2}{625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2} \\ c_2^L &= -\frac{75\alpha\phi^2\theta^2+50\alpha\phi^2-30\alpha\phi\theta^2-40\alpha\phi-24\alpha\theta^2-625\bar{c}\phi^3+450\bar{c}\phi^2+90\bar{c}\phi\theta^2}{625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})\left(25\phi^2-15\phi\theta^2-10\phi-6\theta^2\right)}{625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2} \\ q_2^H &= \frac{5\phi(\alpha-\bar{c})(5\phi-4)\left(5\phi+3\theta^2\right)}{625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2} \\ q_1^L &= \frac{25\phi^2(\alpha-\bar{c})(5\phi-4)}{625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2} \\ q_2^L &= \frac{25\phi^2(\alpha-\bar{c})(5\phi-4)}{625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\cdot(25\phi-16)\left(25\phi^2-15\phi\theta^2-10\phi-6\theta^2\right)^2}{(625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2)^2} \\ \pi_2^H &= \frac{\phi(\alpha-\bar{c})^2(5\phi-4)^2\left(5\phi+3\theta^2\right)^2\cdot(25\phi-4)}{(625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2)^2} \\ \pi_1^L &= \frac{25\phi^3(\alpha-\bar{c})^2(5\phi-4)^2\cdot\left(25\phi-9\theta^2\right)}{(625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2)^2} \\ \pi_2^L &= \frac{25\phi^3(\alpha-\bar{c})^2(5\phi-4)^2\cdot\left(25\phi-9\theta^2\right)}{(625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2)^2} \end{cases} \tag{57}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(50\phi^2-35\phi-9\theta^2\right)}{625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2}$$

Price:

$$\frac{125\alpha\phi^3-75\alpha\phi^2\theta^2-150\alpha\phi^2+30\alpha\phi\theta^2+40\alpha\phi+24\alpha\theta^2+500\bar{c}\phi^3-350\bar{c}\phi^2-90\bar{c}\phi\theta^2}{625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2}$$

Firm Surplus:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(31250\phi^5-5625\phi^4\theta^2-50000\phi^4+5625\phi^3\theta^4-1500\phi^3\theta^2+22250\phi^3-4500\phi^2\theta^4+6300\phi^2\theta^2-1600\phi^2+1530\phi\theta^4-1920\phi\theta^2-576\theta^4\right)}{\left(625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2\right)^2}$$

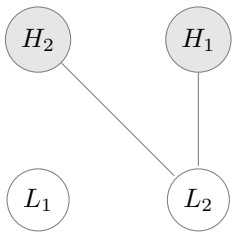
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(50\phi^2-35\phi-9\theta^2\right)^2}{\left(625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2\right)^2}$$

Social Welfare:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(93750\phi^5-5625\phi^4\theta^2-137500\phi^4+5625\phi^3\theta^4-24000\phi^3\theta^2+52875\phi^3-4500\phi^2\theta^4+22050\phi^2\theta^2-1600\phi^2+3555\phi\theta^4-1920\phi\theta^2-576\theta^4\right)}{\left(625\phi^3-75\phi^2\theta^2-500\phi^2-60\phi\theta^2+40\phi+24\theta^2\right)^2}$$

D.2.7 E2C [2H2L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{3}-3\right)=\alpha-2e_2^H-e_1^L\theta+2e_2^L\theta-\bar{c} \\ e_2^H\cdot\left(\frac{25\phi}{3}-3\right)=\alpha-2e_1^H-e_1^L\theta+2e_2^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{4\theta}-4\theta\right)=\alpha-2e_1^H-2e_2^H-3e_2^L\theta-\bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right)=\alpha+3e_1^H+3e_2^H-e_1^L\theta-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{15\phi(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4} \\ e_2^H &= \frac{15\phi(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4} \\ e_1^L &= \frac{4\theta(\alpha-\bar{c})\left(25\phi^2-10\phi\theta^2-15\phi-6\theta^2\right)}{625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4} \\ e_2^L &= \frac{2\theta(\alpha-\bar{c})(5\phi+3)\left(5\phi-4\theta^2\right)}{625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{50\alpha\phi^2\theta^2+75\alpha\phi^2-40\alpha\phi\theta^4-30\alpha\phi\theta^2-24\alpha\theta^4-625\bar{c}\phi^3+450\bar{c}\phi^2\theta^2+90\bar{c}\phi\theta^2}{625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4} \\ c_2^H &= -\frac{50\alpha\phi^2\theta^2+75\alpha\phi^2-40\alpha\phi\theta^4-30\alpha\phi\theta^2-24\alpha\theta^4-625\bar{c}\phi^3+450\bar{c}\phi^2\theta^2+90\bar{c}\phi\theta^2}{625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4} \\ c_1^L &= -\frac{100\alpha\phi^2\theta^2-40\alpha\phi\theta^4-60\alpha\phi\theta^2-24\alpha\theta^4-625\bar{c}\phi^3+400\bar{c}\phi^2\theta^2+75\bar{c}\phi^2+120\bar{c}\phi\theta^2}{625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4} \\ c_2^L &= -\frac{50\alpha\phi^2\theta^2+150\alpha\phi^2-40\alpha\phi\theta^4-90\alpha\phi\theta^2-24\alpha\theta^4-625\bar{c}\phi^3+450\bar{c}\phi^2\theta^2-75\bar{c}\phi^2+150\bar{c}\phi\theta^2}{625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{25\phi^2(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4} \\ q_2^H &= \frac{25\phi^2(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})\left(25\phi^2-10\phi\theta^2-15\phi-6\theta^2\right)}{625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4} \\ q_2^L &= \frac{5\phi(\alpha-\bar{c})(5\phi+3)\left(5\phi-4\theta^2\right)}{625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{25\phi^3(\alpha-\bar{c})^2\left(5\phi-4\theta^2\right)^2\cdot(25\phi-9)}{(625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4)^2} \\ \pi_2^H &= \frac{25\phi^3(\alpha-\bar{c})^2\left(5\phi-4\theta^2\right)^2\cdot(25\phi-9)}{(625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2\cdot\left(25\phi-16\theta^2\right)\left(25\phi^2-10\phi\theta^2-15\phi-6\theta^2\right)^2}{(625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4)^2} \\ \pi_2^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi+3)^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{(625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4)^2} \end{cases} \tag{58}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(50\phi^2-35\phi\theta^2-9\theta^2\right)}{625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4}$$

Price:

$$\frac{125\alpha\phi^3-150\alpha\phi^2\theta^2-75\alpha\phi^2+40\alpha\phi\theta^4+30\alpha\phi\theta^2+24\alpha\theta^4+500\bar{c}\phi^3-350\bar{c}\phi^2\theta^2-90\bar{c}\phi\theta^2}{625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4}$$

Firm Surplus:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(31250\phi^5-50000\phi^4\theta^2-5625\phi^4+22250\phi^3\theta^4-1500\phi^3\theta^2+5625\phi^3-1600\phi^2\theta^6+6300\phi^2\theta^4-4500\phi^2\theta^2-1920\phi\theta^6+1530\phi\theta^4-576\theta^6\right)}{\left(625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}$$

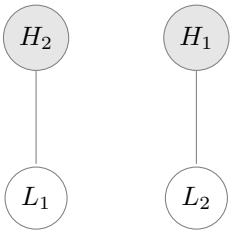
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(50\phi^2-35\phi\theta^2-9\theta^2\right)^2}{\left(625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}$$

Social Welfare:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(93750\phi^5-137500\phi^4\theta^2-5625\phi^4+52875\phi^3\theta^4-24000\phi^3\theta^2+5625\phi^3-1600\phi^2\theta^6+22050\phi^2\theta^4-4500\phi^2\theta^2-1920\phi\theta^6+3555\phi\theta^4-576\theta^6\right)}{\left(625\phi^3-500\phi^2\theta^2-75\phi^2+40\phi\theta^4-60\phi\theta^2+24\theta^4\right)^2}$$

D.2.8 E2D [2H2L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{3}-3\right)=\alpha-2e_2^H-2e_1^L\theta+3e_2^L\theta-\bar{c} \\ e_2^H\cdot\left(\frac{25\phi}{3}-3\right)=\alpha-2e_1^H+3e_1^L\theta-2e_2^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right)=\alpha-2e_1^H+3e_2^H-2e_2^L\theta-\bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right)=\alpha+3e_1^H-2e_2^H-2e_1^L\theta-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{3(\alpha-\bar{c})}{25\phi-3\theta^2-3} \\ e_2^H &= \frac{3(\alpha-\bar{c})}{25\phi-3\theta^2-3} \\ e_1^L &= \frac{3\theta(\alpha-\bar{c})}{25\phi-3\theta^2-3} \\ e_2^L &= \frac{3\theta(\alpha-\bar{c})}{25\phi-3\theta^2-3} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{3\alpha\theta^2+3\alpha-25\bar{c}\phi}{25\phi-3\theta^2-3} \\ c_2^H &= -\frac{3\alpha\theta^2+3\alpha-25\bar{c}\phi}{25\phi-3\theta^2-3} \\ c_1^L &= -\frac{3\alpha\theta^2+3\alpha-25\bar{c}\phi}{25\phi-3\theta^2-3} \\ c_2^L &= -\frac{3\alpha\theta^2+3\alpha-25\bar{c}\phi}{25\phi-3\theta^2-3} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})}{25\phi-3\theta^2-3} \\ q_2^H &= \frac{5\phi(\alpha-\bar{c})}{25\phi-3\theta^2-3} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})}{25\phi-3\theta^2-3} \\ q_2^L &= \frac{5\phi(\alpha-\bar{c})}{25\phi-3\theta^2-3} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\cdot(25\phi-9)}{(25\phi-3\theta^2-3)^2} \\ \pi_2^H &= \frac{\phi(\alpha-\bar{c})^2\cdot(25\phi-9)}{(25\phi-3\theta^2-3)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2\cdot\left(25\phi-9\theta^2\right)}{(25\phi-3\theta^2-3)^2} \\ \pi_2^L &= \frac{\phi(\alpha-\bar{c})^2\cdot\left(25\phi-9\theta^2\right)}{(25\phi-3\theta^2-3)^2} \end{cases} \tag{59}$$

Total Production:

$$\frac{20\phi\left(\alpha-\bar{c}\right)}{25\phi-3\theta^2-3}$$

Price:

$$\frac{5\alpha\phi-3\alpha\theta^2-3\alpha+20\bar{c}\phi}{25\phi-3\theta^2-3}$$

Firm Surplus:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(50\phi-9\theta^2-9\right)}{\left(25\phi-3\theta^2-3\right)^2}$$

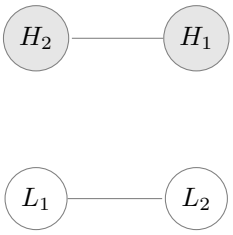
Consumer Surplus:

$$\frac{200\phi^2\left(\alpha-\bar{c}\right)^2}{\left(25\phi-3\theta^2-3\right)^2}$$

Social Welfare:

$$\frac{6\phi\left(\alpha-\bar{c}\right)^2\cdot\left(50\phi-3\theta^2-3\right)}{\left(25\phi-3\theta^2-3\right)^2}$$

D.2.9 E2E [2H2L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{3}-3\right)=\alpha+3e_2^H-2e_1^L\theta-2e_2^L\theta-\bar{c} \\ e_2^H\cdot\left(\frac{25\phi}{3}-3\right)=\alpha+3e_1^H-2e_1^L\theta-2e_2^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right)=\alpha-2e_1^H-2e_2^H+3e_2^L\theta-\bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right)=\alpha-2e_1^H-2e_2^H+3e_1^L\theta-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{3(\alpha-\bar{c})\left(5\phi-6\theta^2\right)}{125\phi^2-90\phi\theta^2-90\phi+36\theta^2} \\ e_2^H &= \frac{3(\alpha-\bar{c})\left(5\phi-6\theta^2\right)}{125\phi^2-90\phi\theta^2-90\phi+36\theta^2} \\ e_1^L &= \frac{3\theta(\alpha-\bar{c})(5\phi-6)}{125\phi^2-90\phi\theta^2-90\phi+36\theta^2} \\ e_2^L &= \frac{3\theta(\alpha-\bar{c})(5\phi-6)}{125\phi^2-90\phi\theta^2-90\phi+36\theta^2} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{30\alpha\phi-36\alpha\theta^2-125\bar{c}\phi^2+90\bar{c}\phi\theta^2+60\bar{c}\phi}{125\phi^2-90\phi\theta^2-90\phi+36\theta^2} \\ c_2^H &= -\frac{30\alpha\phi-36\alpha\theta^2-125\bar{c}\phi^2+90\bar{c}\phi\theta^2+60\bar{c}\phi}{125\phi^2-90\phi\theta^2-90\phi+36\theta^2} \\ c_1^L &= -\frac{30\alpha\phi\theta^2-36\alpha\theta^2-125\bar{c}\phi^2+60\bar{c}\phi\theta^2+90\bar{c}\phi}{125\phi^2-90\phi\theta^2-90\phi+36\theta^2} \\ c_2^L &= -\frac{30\alpha\phi\theta^2-36\alpha\theta^2-125\bar{c}\phi^2+60\bar{c}\phi\theta^2+90\bar{c}\phi}{125\phi^2-90\phi\theta^2-90\phi+36\theta^2} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-6\theta^2\right)}{125\phi^2-90\phi\theta^2-90\phi+36\theta^2} \\ q_2^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-6\theta^2\right)}{125\phi^2-90\phi\theta^2-90\phi+36\theta^2} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-6)}{125\phi^2-90\phi\theta^2-90\phi+36\theta^2} \\ q_2^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-6)}{125\phi^2-90\phi\theta^2-90\phi+36\theta^2} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-6\theta^2\right)^2\cdot(25\phi-9)}{(125\phi^2-90\phi\theta^2-90\phi+36\theta^2)^2} \\ \pi_2^H &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-6\theta^2\right)^2\cdot(25\phi-9)}{(125\phi^2-90\phi\theta^2-90\phi+36\theta^2)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-6)^2\cdot\left(25\phi-9\theta^2\right)}{(125\phi^2-90\phi\theta^2-90\phi+36\theta^2)^2} \\ \pi_2^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-6)^2\cdot\left(25\phi-9\theta^2\right)}{(125\phi^2-90\phi\theta^2-90\phi+36\theta^2)^2} \end{cases} \tag{60}$$

Total Production:

$$\frac{20\phi\left(\alpha-\bar{c}\right)\left(5\phi-3\theta^2-3\right)}{125\phi^2-90\phi\theta^2-90\phi+36\theta^2}$$

Price:

$$\frac{25\alpha\phi^2-30\alpha\phi\theta^2-30\alpha\phi+36\alpha\theta^2+100\bar{c}\phi^2-60\bar{c}\phi\theta^2-60\bar{c}\phi}{125\phi^2-90\phi\theta^2-90\phi+36\theta^2}$$

Firm Surplus:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(1250\phi^3-1725\phi^2\theta^2-1725\phi^2+900\phi\theta^4+1080\phi\theta^2+900\phi-324\theta^4-324\theta^2\right)}{\left(125\phi^2-90\phi\theta^2-90\phi+36\theta^2\right)^2}$$

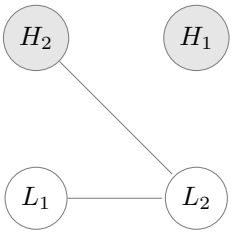
Consumer Surplus:

$$\frac{200\phi^2\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2-3\right)^2}{\left(125\phi^2-90\phi\theta^2-90\phi+36\theta^2\right)^2}$$

Social Welfare:

$$\frac{6\phi\left(\alpha-\bar{c}\right)^2\cdot\left(1250\phi^3-1575\phi^2\theta^2-1575\phi^2+600\phi\theta^4+960\phi\theta^2+600\phi-108\theta^4-108\theta^2\right)}{\left(125\phi^2-90\phi\theta^2-90\phi+36\theta^2\right)^2}$$

D.2.10 E2F [2H2L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{4}-4\right) = \alpha-2e_2^H-2e_1^L\theta-3e_2^L\theta-\bar{c} \\ e_2^H\cdot\left(\frac{25\phi}{3}-3\right) = \alpha-e_1^H-2e_1^L\theta+2e_2^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right) = \alpha-e_1^H-2e_2^H+2e_2^L\theta-\bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right) = \alpha-e_1^H+3e_2^H+3e_1^L\theta-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{4(\alpha-\bar{c})\left(125\phi^3-125\phi^2\theta^2-75\phi^2+45\phi\theta^2+18\theta^4\right)}{3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4} \\ e_2^H &= \frac{15\phi(\alpha-\bar{c})(5\phi-4)\left(5\phi-3\theta^2\right)}{3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4} \\ e_1^L &= \frac{15\phi\theta(\alpha-\bar{c})(5\phi-4)(5\phi-3)}{3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4} \\ e_2^L &= \frac{2\theta(\alpha-\bar{c})(5\phi-4)(5\phi-3\theta)(5\phi+3\theta)}{3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{500\alpha\phi^3-500\alpha\phi^2\theta^2-300\alpha\phi^2+180\alpha\phi\theta^2+72\alpha\theta^4-3125\bar{c}\phi^4+1625\bar{c}\phi^3\theta^2+2625\bar{c}\phi^3-525\bar{c}\phi^2\theta^2-300\bar{c}\phi^2-180\bar{c}\phi\theta^4-180\bar{c}\phi\theta^2}{3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4} \\ c_2^H &= -\frac{250\alpha\phi^3\theta^2+375\alpha\phi^3-425\alpha\phi^2\theta^2-300\alpha\phi^2-90\alpha\phi\theta^4+180\alpha\phi\theta^2+72\alpha\theta^4-3125\bar{c}\phi^4+1375\bar{c}\phi^3\theta^2+2750\bar{c}\phi^3-600\bar{c}\phi^2\theta^2-300\bar{c}\phi^2-90\bar{c}\phi\theta^4-180\bar{c}\phi\theta^2}{3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4} \\ c_1^L &= -\frac{625\alpha\phi^3\theta^2-725\alpha\phi^2\theta^2-90\alpha\phi\theta^4+180\alpha\phi\theta^2+72\alpha\theta^4-3125\bar{c}\phi^4+1000\bar{c}\phi^3\theta^2+3125\bar{c}\phi^3-300\bar{c}\phi^2\theta^2-600\bar{c}\phi^2-90\bar{c}\phi\theta^4-180\bar{c}\phi\theta^2}{3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4} \\ c_2^L &= -\frac{625\alpha\phi^3\theta^2+375\alpha\phi^3-950\alpha\phi^2\theta^2-300\alpha\phi^2-90\alpha\phi\theta^4+360\alpha\phi\theta^2+72\alpha\theta^4-3125\bar{c}\phi^4+1000\bar{c}\phi^3\theta^2+2750\bar{c}\phi^3-75\bar{c}\phi^2\theta^2-300\bar{c}\phi^2-90\bar{c}\phi\theta^4-360\bar{c}\phi\theta^2}{3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})\left(125\phi^3-125\phi^2\theta^2-75\phi^2+45\phi\theta^2+18\theta^4\right)}{3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4} \\ q_2^H &= \frac{25\phi^2(\alpha-\bar{c})(5\phi-4)\left(5\phi-3\theta^2\right)}{3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4} \\ q_1^L &= \frac{25\phi^2(\alpha-\bar{c})(5\phi-4)(5\phi-3)}{3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4} \\ q_2^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-4)(5\phi-3\theta)(5\phi+3\theta)}{3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\cdot(25\phi-16)\left(125\phi^3-125\phi^2\theta^2-75\phi^2+45\phi\theta^2+18\theta^4\right)^2}{(3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4)^2} \\ \pi_2^H &= \frac{25\phi^3(\alpha-\bar{c})^2(5\phi-4)^2\left(5\phi-3\theta^2\right)^2\cdot(25\phi-9)}{(3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4)^2} \\ \pi_1^L &= \frac{25\phi^3(\alpha-\bar{c})^2(5\phi-4)^2(5\phi-3)^2\cdot\left(25\phi-9\theta^2\right)}{(3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4)^2} \\ \pi_2^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-4)^2(5\phi-3\theta)^2(5\phi+3\theta)^2\cdot\left(25\phi-4\theta^2\right)}{(3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4)^2} \end{cases} \tag{61}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(250\phi^3-100\phi^2\theta^2-225\phi^2+30\phi\theta^2+30\phi+9\theta^4+18\theta^2\right)}{3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4}$$

Price:

$$\frac{625\alpha\phi^4-625\alpha\phi^3\theta^2-875\alpha\phi^3+725\alpha\phi^2\theta^2+300\alpha\phi^2+90\alpha\phi\theta^4-180\alpha\phi\theta^2-72\alpha\theta^4+2500\bar{c}\phi^4-1000\bar{c}\phi^3\theta^2-2250\bar{c}\phi^3+300\bar{c}\phi^2\theta^2+300\bar{c}\phi^2+90\bar{c}\phi\theta^4+180\bar{c}\phi\theta^2}{3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4}$$

Firm Surplus:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(1562500\phi^7-1453125\phi^6\theta^2-3203125\phi^6+531250\phi^5\theta^4+2381250\phi^5\theta^2+2306250\phi^5-649375\phi^4\theta^4-1219375\phi^4\theta^2-705000\phi^4-112500\phi^3\theta^6+240750\phi^3\theta^4+225000\phi^3\theta^2+90000\phi^3+104400\phi^2\theta^6-73800\phi^2\theta^4-32400\phi^2\theta^2+8100\phi\theta^8-12960\phi\theta^6+32400\phi\theta^4-5184\theta^8-5184\theta^6\right)}{\left(3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4\right)^2}$$

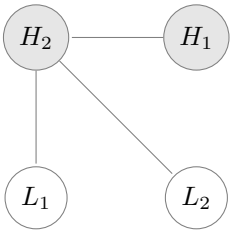
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(250\phi^3-100\phi^2\theta^2-225\phi^2+30\phi\theta^2+30\phi+9\theta^4+18\theta^2\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4\right)^2}$$

Social Welfare:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(4687500\phi^7-3953125\phi^6\theta^2-8828125\phi^6+1031250\phi^5\theta^4+5381250\phi^5\theta^2+5587500\phi^5-724375\phi^4\theta^4-1744375\phi^4\theta^2-1380000\phi^4-202500\phi^3\theta^6-96750\phi^3\theta^4-90000\phi^3\theta^2+135000\phi^3+131400\phi^2\theta^6+7200\phi^2\theta^4+21600\phi^2\theta^2+12150\phi\theta^8+3240\phi\theta^6+48600\phi\theta^4-5184\theta^8-5184\theta^6\right)}{\left(3125\phi^4-1625\phi^3\theta^2-3125\phi^3+1025\phi^2\theta^2+600\phi^2+180\phi\theta^4-72\theta^4\right)^2}$$

D.2.11 E3A [2H2L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{3}-3\right)=\alpha+e_2^H-2e_1^L\theta-2e_2^L\theta-\bar{c} \\ e_2^H\cdot(25\phi-1)=\alpha+3e_1^H+3e_1^L\theta+3e_2^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right)=\alpha-2e_1^H+e_2^H-2e_2^L\theta-\bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right)=\alpha-2e_1^H+e_2^H-2e_1^L\theta-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{15\phi(\alpha-\bar{c})\left(5\phi-3\theta^2\right)}{625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2} \\ e_2^H &= \frac{(\alpha-\bar{c})\left(25\phi^2+15\phi\theta^2-18\theta^2\right)}{625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2} \\ e_1^L &= \frac{15\phi\theta(\alpha-\bar{c})(5\phi-3)}{625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2} \\ e_2^L &= \frac{15\phi\theta(\alpha-\bar{c})(5\phi-3)}{625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{100\alpha\phi^2-30\alpha\phi\theta^2-18\alpha\theta^2-625\bar{c}\phi^3+75\bar{c}\phi^2\theta^2+150\bar{c}\phi^2+90\bar{c}\phi\theta^2}{625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2} \\ c_2^H &= -\frac{150\alpha\phi^2\theta^2+100\alpha\phi^2-120\alpha\phi\theta^2-18\alpha\theta^2-625\bar{c}\phi^3-75\bar{c}\phi^2\theta^2+150\bar{c}\phi^2+180\bar{c}\phi\theta^2}{625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2} \\ c_1^L &= -\frac{75\alpha\phi^2\theta^2+25\alpha\phi^2-30\alpha\phi\theta^2-18\alpha\theta^2-625\bar{c}\phi^3+225\bar{c}\phi^2+90\bar{c}\phi\theta^2}{625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2} \\ c_2^L &= -\frac{75\alpha\phi^2\theta^2+25\alpha\phi^2-30\alpha\phi\theta^2-18\alpha\theta^2-625\bar{c}\phi^3+225\bar{c}\phi^2+90\bar{c}\phi\theta^2}{625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{25\phi^2(\alpha-\bar{c})\left(5\phi-3\theta^2\right)}{625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2} \\ q_2^H &= \frac{5\phi(\alpha-\bar{c})\left(25\phi^2+15\phi\theta^2-18\theta^2\right)}{625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2} \\ q_1^L &= \frac{25\phi^2(\alpha-\bar{c})(5\phi-3)}{625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2} \\ q_2^L &= \frac{25\phi^2(\alpha-\bar{c})(5\phi-3)}{625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{25\phi^3(\alpha-\bar{c})^2\left(5\phi-3\theta^2\right)^2\cdot(25\phi-9)}{(625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2)^2} \\ \pi_2^H &= \frac{\phi(\alpha-\bar{c})^2\cdot(25\phi-1)\left(25\phi^2+15\phi\theta^2-18\theta^2\right)^2}{(625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2)^2} \\ \pi_1^L &= \frac{25\phi^3(\alpha-\bar{c})^2(5\phi-3)^2\cdot\left(25\phi-9\theta^2\right)}{(625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2)^2} \\ \pi_2^L &= \frac{25\phi^3(\alpha-\bar{c})^2(5\phi-3)^2\cdot\left(25\phi-9\theta^2\right)}{(625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2)^2} \end{cases} \tag{62}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(50\phi^2-15\phi-9\theta^2\right)}{625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2}$$

Price:

$$\frac{125\alpha\phi^3-75\alpha\phi^2\theta^2-100\alpha\phi^2+30\alpha\phi\theta^2+18\alpha\theta^2+500\bar{c}\phi^3-150\bar{c}\phi^2-90\bar{c}\phi\theta^2}{625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2}$$

Firm Surplus:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(31250\phi^5-5625\phi^4\theta^2-21875\phi^4+5625\phi^3\theta^4-1500\phi^3\theta^2+5625\phi^3-7875\phi^2\theta^4-1575\phi^2\theta^2+4320\phi\theta^4-162\theta^4\right)}{\left(625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2\right)^2}$$

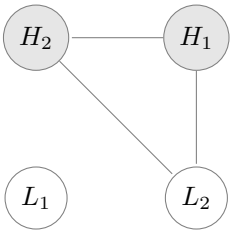
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(50\phi^2-15\phi-9\theta^2\right)^2}{\left(625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2\right)^2}$$

Social Welfare:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(93750\phi^5-5625\phi^4\theta^2-59375\phi^4+5625\phi^3\theta^4-24000\phi^3\theta^2+11250\phi^3-7875\phi^2\theta^4+5175\phi^2\theta^2+6345\phi\theta^4-162\theta^4\right)}{\left(625\phi^3-75\phi^2\theta^2-250\phi^2-60\phi\theta^2+18\theta^2\right)^2}$$

D.2.12 E3B [2H2L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{2}-2\right) = \alpha+2e_2^H-e_1^L\theta+2e_2^L\theta-\bar{c} \\ e_2^H\cdot\left(\frac{25\phi}{2}-2\right) = \alpha+2e_1^H-e_1^L\theta+2e_2^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{4\theta}-4\theta\right) = \alpha-3e_1^H-3e_2^H-3e_2^L\theta-\bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right) = \alpha+2e_1^H+2e_2^H-e_1^L\theta-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{2(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2} \\ e_2^H &= \frac{2(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2} \\ e_1^L &= \frac{4\theta(\alpha-\bar{c})\left(5\phi-2\theta^2-4\right)}{125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2} \\ e_2^L &= \frac{2\theta(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{10\alpha\phi\theta^2+20\alpha\phi-8\alpha\theta^4-16\alpha\theta^2-125\bar{c}\phi^2+90\bar{c}\phi\theta^2+20\bar{c}\phi}{125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2} \\ c_2^H &= -\frac{10\alpha\phi\theta^2+20\alpha\phi-8\alpha\theta^4-16\alpha\theta^2-125\bar{c}\phi^2+90\bar{c}\phi\theta^2+20\bar{c}\phi}{125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2} \\ c_1^L &= -\frac{20\alpha\phi\theta^2-8\alpha\theta^4-16\alpha\theta^2-125\bar{c}\phi^2+80\bar{c}\phi\theta^2+40\bar{c}\phi}{125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2} \\ c_2^L &= -\frac{10\alpha\phi\theta^2+20\alpha\phi-8\alpha\theta^4-16\alpha\theta^2-125\bar{c}\phi^2+90\bar{c}\phi\theta^2+20\bar{c}\phi}{125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2} \\ q_2^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-2\theta^2-4\right)}{125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2} \\ q_2^L &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-4\theta^2\right)^2\cdot(25\phi-4)}{(125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2)^2} \\ \pi_2^H &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-4\theta^2\right)^2\cdot(25\phi-4)}{(125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2\cdot\left(25\phi-16\theta^2\right)\left(5\phi-2\theta^2-4\right)^2}{(125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2)^2} \\ \pi_2^L &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-4\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{(125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2)^2} \end{cases} \tag{63}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(10\phi-7\theta^2-2\right)}{125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2}$$

Price:

$$\frac{25\alpha\phi^2-30\alpha\phi\theta^2-20\alpha\phi+8\alpha\theta^4+16\alpha\theta^2+100\bar{c}\phi^2-70\bar{c}\phi\theta^2-20\bar{c}\phi}{125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2}$$

Firm Surplus:

$$\frac{4\phi\left(\alpha-\bar{c}\right)^2\cdot\left(625\phi^3-1000\phi^2\theta^2-300\phi^2+445\phi\theta^4+340\phi\theta^2+100\phi-32\theta^6-96\theta^4-64\theta^2\right)}{\left(125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2\right)^2}$$

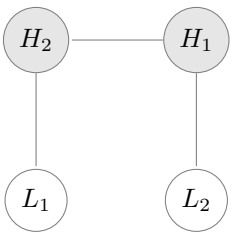
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(10\phi-7\theta^2-2\right)^2}{\left(125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2\right)^2}$$

Social Welfare:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(3750\phi^3-5500\phi^2\theta^2-1600\phi^2+2115\phi\theta^4+1380\phi\theta^2+300\phi-64\theta^6-192\theta^4-128\theta^2\right)}{\left(125\phi^2-100\phi\theta^2-40\phi+8\theta^4+16\theta^2\right)^2}$$

D.2.13 E3C [2H2L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{2}-2\right)=\alpha+2e_2^H-2e_1^L\theta+3e_2^L\theta-\bar{c} \\ e_2^H\cdot\left(\frac{25\phi}{2}-2\right)=\alpha+2e_1^H+3e_1^L\theta-2e_2^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right)=\alpha-3e_1^H+2e_2^H-2e_2^L\theta-\bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right)=\alpha+2e_1^H-3e_2^H-2e_1^L\theta-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{10\phi(\alpha-\bar{c})}{125\phi^2-15\phi\theta^2-40\phi+6\theta^2} \\ e_2^H &= \frac{10\phi(\alpha-\bar{c})}{125\phi^2-15\phi\theta^2-40\phi+6\theta^2} \\ e_1^L &= \frac{3\theta(\alpha-\bar{c})(5\phi-2)}{125\phi^2-15\phi\theta^2-40\phi+6\theta^2} \\ e_2^L &= \frac{3\theta(\alpha-\bar{c})(5\phi-2)}{125\phi^2-15\phi\theta^2-40\phi+6\theta^2} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{15\alpha\phi\theta^2+20\alpha\phi-6\alpha\theta^2-125\bar{c}\phi^2+20\bar{c}\phi}{125\phi^2-15\phi\theta^2-40\phi+6\theta^2} \\ c_2^H &= -\frac{15\alpha\phi\theta^2+20\alpha\phi-6\alpha\theta^2-125\bar{c}\phi^2+20\bar{c}\phi}{125\phi^2-15\phi\theta^2-40\phi+6\theta^2} \\ c_1^L &= -\frac{15\alpha\phi\theta^2+10\alpha\phi-6\alpha\theta^2-125\bar{c}\phi^2+30\bar{c}\phi}{125\phi^2-15\phi\theta^2-40\phi+6\theta^2} \\ c_2^L &= -\frac{15\alpha\phi\theta^2+10\alpha\phi-6\alpha\theta^2-125\bar{c}\phi^2+30\bar{c}\phi}{125\phi^2-15\phi\theta^2-40\phi+6\theta^2} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{25\phi^2(\alpha-\bar{c})}{125\phi^2-15\phi\theta^2-40\phi+6\theta^2} \\ q_2^H &= \frac{25\phi^2(\alpha-\bar{c})}{125\phi^2-15\phi\theta^2-40\phi+6\theta^2} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-2)}{125\phi^2-15\phi\theta^2-40\phi+6\theta^2} \\ q_2^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-2)}{125\phi^2-15\phi\theta^2-40\phi+6\theta^2} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{25\phi^3(\alpha-\bar{c})^2\cdot(25\phi-4)}{(125\phi^2-15\phi\theta^2-40\phi+6\theta^2)^2} \\ \pi_2^H &= \frac{25\phi^3(\alpha-\bar{c})^2\cdot(25\phi-4)}{(125\phi^2-15\phi\theta^2-40\phi+6\theta^2)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-2)^2\cdot\left(25\phi-9\theta^2\right)}{(125\phi^2-15\phi\theta^2-40\phi+6\theta^2)^2} \\ \pi_2^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-2)^2\cdot\left(25\phi-9\theta^2\right)}{(125\phi^2-15\phi\theta^2-40\phi+6\theta^2)^2} \end{cases} \tag{64}$$

Total Production:

$$\frac{20\phi\left(\alpha-\bar{c}\right)\left(5\phi-1\right)}{125\phi^2-15\phi\theta^2-40\phi+6\theta^2}$$

Price:

$$\frac{25\alpha\phi^2-15\alpha\phi\theta^2-20\alpha\phi+6\alpha\theta^2+100\bar{c}\phi^2-20\bar{c}\phi}{125\phi^2-15\phi\theta^2-40\phi+6\theta^2}$$

Firm Surplus:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(1250\phi^3-225\phi^2\theta^2-600\phi^2+180\phi\theta^2+100\phi-36\theta^2\right)}{\left(125\phi^2-15\phi\theta^2-40\phi+6\theta^2\right)^2}$$

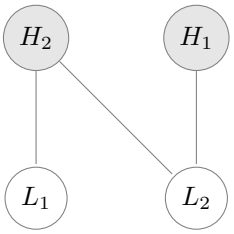
Consumer Surplus:

$$\frac{200\phi^2\left(\alpha-\bar{c}\right)^2\left(5\phi-1\right)^2}{\left(125\phi^2-15\phi\theta^2-40\phi+6\theta^2\right)^2}$$

Social Welfare:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(3750\phi^3-225\phi^2\theta^2-1600\phi^2+180\phi\theta^2+200\phi-36\theta^2\right)}{\left(125\phi^2-15\phi\theta^2-40\phi+6\theta^2\right)^2}$$

D.2.14 E3D [2H2L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{3}-3\right) = \alpha-3e_2^H-2e_1^L\theta+2e_2^L\theta-\bar{c} \\ e_2^H\cdot\left(\frac{25\phi}{2}-2\right) = \alpha-2e_1^H+3e_1^L\theta+2e_2^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right) = \alpha-2e_1^H+2e_2^H-3e_2^L\theta-\bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right) = \alpha+3e_1^H+2e_2^H-2e_1^L\theta-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{3(\alpha-\bar{c})\left(125\phi^3-75\phi^2\theta^2-50\phi^2+12\theta^4\right)}{3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4} \\ e_2^H &= \frac{10\phi(\alpha-\bar{c})\left(25\phi^2-15\phi-6\theta^4\right)}{3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4} \\ e_1^L &= \frac{3\theta(\alpha-\bar{c})\left(125\phi^3-50\phi^2\theta^2-75\phi^2+12\theta^2\right)}{3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4} \\ e_2^L &= \frac{10\phi\theta(\alpha-\bar{c})\left(25\phi^2-15\phi\theta^2-6\right)}{3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{250\alpha\phi^3\theta^2+375\alpha\phi^3-150\alpha\phi^2\theta^4-225\alpha\phi^2\theta^2-150\alpha\phi^2-60\alpha\phi\theta^2+36\alpha\theta^4-3125\bar{c}\phi^4+1375\bar{c}\phi^3\theta^2+1250\bar{c}\phi^3+150\bar{c}\phi^2\theta^4+150\bar{c}\phi^2-120\bar{c}\phi\theta^4-60\bar{c}\phi\theta^2}{3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4} \\ c_2^H &= -\frac{625\alpha\phi^3\theta^2+250\alpha\phi^3-300\alpha\phi^2\theta^4-225\alpha\phi^2\theta^2-150\alpha\phi^2-60\alpha\phi\theta^4-60\alpha\phi\theta^2+36\alpha\theta^4-3125\bar{c}\phi^4+1000\bar{c}\phi^3\theta^2+1375\bar{c}\phi^3+300\bar{c}\phi^2\theta^4+150\bar{c}\phi^2-60\bar{c}\phi\theta^4-60\bar{c}\phi\theta^2}{3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4} \\ c_1^L &= -\frac{375\alpha\phi^3\theta^2+250\alpha\phi^3-150\alpha\phi^2\theta^4-225\alpha\phi^2\theta^2-150\alpha\phi^2-60\alpha\phi\theta^4+36\alpha\theta^4-3125\bar{c}\phi^4+1250\bar{c}\phi^3\theta^2+1375\bar{c}\phi^3+150\bar{c}\phi^2\theta^4+150\bar{c}\phi^2-60\bar{c}\phi\theta^4-120\bar{c}\phi\theta^2}{3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4} \\ c_2^L &= -\frac{250\alpha\phi^3\theta^2+625\alpha\phi^3-150\alpha\phi^2\theta^4-225\alpha\phi^2\theta^2-300\alpha\phi^2-60\alpha\phi\theta^4-60\alpha\phi\theta^2+36\alpha\theta^4-3125\bar{c}\phi^4+1375\bar{c}\phi^3\theta^2+1000\bar{c}\phi^3+150\bar{c}\phi^2\theta^4+300\bar{c}\phi^2-60\bar{c}\phi\theta^4-60\bar{c}\phi\theta^2}{3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})\left(125\phi^3-75\phi^2\theta^2-50\phi^2+12\theta^4\right)}{3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4} \\ q_2^H &= \frac{25\phi^2(\alpha-\bar{c})\left(25\phi^2-15\phi-6\theta^4\right)}{3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})\left(125\phi^3-50\phi^2\theta^2-75\phi^2+12\theta^2\right)}{3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4} \\ q_2^L &= \frac{25\phi^2(\alpha-\bar{c})\left(25\phi^2-15\phi\theta^2-6\right)}{3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\cdot(25\phi-9)\left(125\phi^3-75\phi^2\theta^2-50\phi^2+12\theta^4\right)^2}{(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4)^2} \\ \pi_2^H &= \frac{25\phi^3(\alpha-\bar{c})^2\cdot(25\phi-4)\left(25\phi^2-15\phi-6\theta^4\right)^2}{(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2\cdot\left(25\phi-9\theta^2\right)\left(125\phi^3-50\phi^2\theta^2-75\phi^2+12\theta^2\right)^2}{(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4)^2} \\ \pi_2^L &= \frac{25\phi^3(\alpha-\bar{c})^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi\theta^2-6\right)^2}{(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4)^2} \end{cases} \tag{65}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(250\phi^3-100\phi^2\theta^2-100\phi^2-15\phi\theta^4-15\phi+6\theta^4+6\theta^2\right)}{3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4}$$

Price:

$$\frac{625\alpha\phi^4-625\alpha\phi^3\theta^2-625\alpha\phi^3+150\alpha\phi^2\theta^4+225\alpha\phi^2\theta^2+150\alpha\phi^2+60\alpha\phi\theta^4+60\alpha\phi\theta^2-36\alpha\theta^4+2500\bar{c}\phi^4-1000\bar{c}\phi^3\theta^2-1000\bar{c}\phi^3-150\bar{c}\phi^2\theta^4-150\bar{c}\phi^2+60\bar{c}\phi\theta^4+60\bar{c}\phi\theta^2}{3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4}$$

Firm Surplus:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(1562500\phi^7-1453125\phi^6\theta^2-1453125\phi^6+343750\phi^5\theta^4+712500\phi^5\theta^2+343750\phi^5-45000\phi^4\theta^6+99375\phi^4\theta^4+99375\phi^4\theta^2-45000\phi^4+22500\phi^3\theta^8-45000\phi^3\theta^6-150000\phi^3\theta^4-45000\phi^3\theta^2+22500\phi^3-3600\phi^2\theta^8+27000\phi^2\theta^6+27000\phi^2\theta^4-3600\phi^2\theta^2+3600\phi^8+3600\phi\theta^4-1296\theta^8-1296\theta^6\right)}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}$$

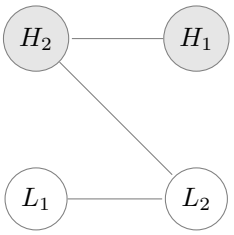
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(250\phi^3-100\phi^2\theta^2-100\phi^2-15\phi\theta^4-15\phi+6\theta^4+6\theta^2\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}$$

Social Welfare:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(4687500\phi^7-3953125\phi^6\theta^2-3953125\phi^6+468750\phi^5\theta^4+1712500\phi^5\theta^2+468750\phi^5+105000\phi^4\theta^6+399375\phi^4\theta^4+399375\phi^4\theta^2+105000\phi^4+33750\phi^3\theta^8-105000\phi^3\theta^6-247500\phi^3\theta^4-105000\phi^3\theta^2+33750\phi^3-12600\phi^2\theta^8+18000\phi^2\theta^6+18000\phi^2\theta^4-12600\phi^2\theta^2+5400\phi^8+3600\phi\theta^6+5400\phi\theta^4-1296\theta^8-1296\theta^6\right)}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}$$

D.2.15 E3E [2H2L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{3}-3\right) = \alpha+2e_2^H-2e_1^L\theta-3e_2^L\theta-\bar{c} \\ e_2^H\cdot\left(\frac{25\phi}{2}-2\right) = \alpha+3e_1^H-2e_1^L\theta+2e_2^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right) = \alpha-2e_1^H-3e_2^H+2e_2^L\theta-\bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right) = \alpha-2e_1^H+2e_2^H+3e_1^L\theta-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{3(\alpha-\bar{c})\left(125\phi^3-125\phi^2\theta^2+12\theta^4\right)}{3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4} \\ e_2^H &= \frac{10\phi(\alpha-\bar{c})\left(25\phi^2-15\phi\theta^2-6\theta^2\right)}{3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4} \\ e_1^L &= \frac{3\theta(\alpha-\bar{c})\left(125\phi^3-125\phi^2+12\theta^2\right)}{3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4} \\ e_2^L &= \frac{10\phi\theta(\alpha-\bar{c})\left(25\phi^2-15\phi-6\theta^2\right)}{3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{625\alpha\phi^3-525\alpha\phi^2\theta^2-60\alpha\phi\theta^2+36\alpha\theta^4-3125\bar{c}\phi^4+1625\bar{c}\phi^3\theta^2+1000\bar{c}\phi^3+300\bar{c}\phi^2\theta^2-120\bar{c}\phi\theta^4-60\bar{c}\phi\theta^2}{3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4} \\ c_2^H &= -\frac{250\alpha\phi^3\theta^2+625\alpha\phi^3-675\alpha\phi^2\theta^2-60\alpha\phi\theta^4-60\alpha\phi\theta^2+36\alpha\theta^4-3125\bar{c}\phi^4+1375\bar{c}\phi^3\theta^2+1000\bar{c}\phi^3+450\bar{c}\phi^2\theta^2-60\bar{c}\phi\theta^4-60\bar{c}\phi\theta^2}{3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4} \\ c_1^L &= -\frac{625\alpha\phi^3\theta^2-525\alpha\phi^2\theta^2-60\alpha\phi\theta^4+36\alpha\theta^4-3125\bar{c}\phi^4+1000\bar{c}\phi^3\theta^2+1625\bar{c}\phi^3+300\bar{c}\phi^2\theta^2-60\bar{c}\phi\theta^4-120\bar{c}\phi\theta^2}{3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4} \\ c_2^L &= -\frac{625\alpha\phi^3\theta^2+250\alpha\phi^3-675\alpha\phi^2\theta^2-60\alpha\phi\theta^4-60\alpha\phi\theta^2+36\alpha\theta^4-3125\bar{c}\phi^4+1000\bar{c}\phi^3\theta^2+1375\bar{c}\phi^3+450\bar{c}\phi^2\theta^2-60\bar{c}\phi\theta^4-60\bar{c}\phi\theta^2}{3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})\left(125\phi^3-125\phi^2\theta^2+12\theta^4\right)}{3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4} \\ q_2^H &= \frac{25\phi^2(\alpha-\bar{c})\left(25\phi^2-15\phi\theta^2-6\theta^2\right)}{3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})\left(125\phi^3-125\phi^2+12\theta^2\right)}{3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4} \\ q_2^L &= \frac{25\phi^2(\alpha-\bar{c})\left(25\phi^2-15\phi-6\theta^2\right)}{3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\cdot(25\phi-9)\left(125\phi^3-125\phi^2\theta^2+12\theta^4\right)^2}{(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4)^2} \\ \pi_2^H &= \frac{25\phi^3(\alpha-\bar{c})^2\cdot(25\phi-4)\left(25\phi^2-15\phi\theta^2-6\theta^2\right)^2}{(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2\cdot\left(25\phi-9\theta^2\right)\left(125\phi^3-125\phi^2+12\theta^2\right)^2}{(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4)^2} \\ \pi_2^L &= \frac{25\phi^3(\alpha-\bar{c})^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi-6\theta^2\right)^2}{(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4)^2} \end{cases} \tag{66}$$

Total Production:

$$\frac{20\phi\left(\alpha-\bar{c}\right)\left(125\phi^3-50\phi^2\theta^2-50\phi^2-15\phi\theta^2+3\theta^4+3\theta^2\right)}{3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4}$$

Price:

$$\frac{625\alpha\phi^4-625\alpha\phi^3\theta^2-625\alpha\phi^3+525\alpha\phi^2\theta^2+60\alpha\phi\theta^4+60\alpha\phi\theta^2-36\alpha\theta^4+2500\bar{c}\phi^4-1000\bar{c}\phi^3\theta^2-1000\bar{c}\phi^3-300\bar{c}\phi^2\theta^2+60\bar{c}\phi\theta^4+60\bar{c}\phi\theta^2}{3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4}$$

Firm Surplus:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(1562500\phi^7-1453125\phi^6\theta^2-1453125\phi^6+531250\phi^5\theta^4+337500\phi^5\theta^2+531250\phi^5+54375\phi^4\theta^4+54375\phi^4\theta^2-75000\phi^3\theta^6-45000\phi^3\theta^4-75000\phi^3\theta^2+23400\phi^2\theta^6+23400\phi^2\theta^4+3600\phi\theta^8+3600\phi\theta^4-1296\theta^8-1296\theta^6\right)}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}$$

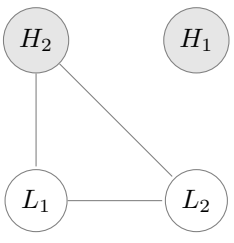
Consumer Surplus:

$$\frac{200\phi^2\left(\alpha-\bar{c}\right)^2\left(125\phi^3-50\phi^2\theta^2-50\phi^2-15\phi\theta^2+3\theta^4+3\theta^2\right)^2}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}$$

Social Welfare:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(4687500\phi^7-3953125\phi^6\theta^2-3953125\phi^6+1031250\phi^5\theta^4+587500\phi^5\theta^2+1031250\phi^5+504375\phi^4\theta^4+504375\phi^4\theta^2-135000\phi^3\theta^6-120000\phi^3\theta^4-135000\phi^3\theta^2+5400\phi^2\theta^6+5400\phi^2\theta^4+5400\phi\theta^8+3600\phi\theta^6+5400\phi\theta^4-1296\theta^8-1296\theta^6\right)}{\left(3125\phi^4-1625\phi^3\theta^2-1625\phi^3+225\phi^2\theta^2+120\phi\theta^4+120\phi\theta^2-36\theta^4\right)^2}$$

D.2.16 E3F [2H2L]



$$Equations: \begin{cases} e_1^H \cdot \left(\frac{25\phi}{4} - 4\right) = \alpha - 3e_2^H - 3e_1^L\theta - 3e_2^L\theta - \bar{c} \\ e_2^H \cdot \left(\frac{25\phi}{2} - 2\right) = \alpha - e_1^H + 2e_1^L\theta + 2e_2^L\theta - \bar{c} \\ e_1^L \cdot \left(\frac{25\phi}{2\theta} - 2\theta\right) = \alpha - e_1^H + 2e_2^H + 2e_2^L\theta - \bar{c} \\ e_2^L \cdot \left(\frac{25\phi}{2\theta} - 2\theta\right) = \alpha - e_1^H + 2e_2^H + 2e_1^L\theta - \bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{4(\alpha-\bar{c})\left(5\phi-4\theta^2-2\right)}{125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8} \\ e_2^H &= \frac{2(\alpha-\bar{c})(5\phi-4)}{125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8} \\ e_1^L &= \frac{2\theta(\alpha-\bar{c})(5\phi-4)}{125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8} \\ e_2^L &= \frac{2\theta(\alpha-\bar{c})(5\phi-4)}{125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{20\alpha\phi-16\alpha\theta^2-8\alpha-125\bar{c}\phi^2+40\bar{c}\phi\theta^2+80\bar{c}\phi}{125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8} \\ c_2^H &= -\frac{20\alpha\phi\theta^2+10\alpha\phi-16\alpha\theta^2-8\alpha-125\bar{c}\phi^2+20\bar{c}\phi\theta^2+90\bar{c}\phi}{125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8} \\ c_1^L &= -\frac{20\alpha\phi\theta^2+10\alpha\phi-16\alpha\theta^2-8\alpha-125\bar{c}\phi^2+20\bar{c}\phi\theta^2+90\bar{c}\phi}{125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8} \\ c_2^L &= -\frac{20\alpha\phi\theta^2+10\alpha\phi-16\alpha\theta^2-8\alpha-125\bar{c}\phi^2+20\bar{c}\phi\theta^2+90\bar{c}\phi}{125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-4\theta^2-2\right)}{125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8} \\ q_2^H &= \frac{5\phi(\alpha-\bar{c})(5\phi-4)}{125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-4)}{125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8} \\ q_2^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-4)}{125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\cdot(25\phi-16)\left(5\phi-4\theta^2-2\right)^2}{(125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8)^2} \\ \pi_2^H &= \frac{\phi(\alpha-\bar{c})^2(5\phi-4)^2\cdot(25\phi-4)}{(125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-4)^2\cdot\left(25\phi-4\theta^2\right)}{(125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8)^2} \\ \pi_2^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-4)^2\cdot\left(25\phi-4\theta^2\right)}{(125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8)^2} \end{cases} \tag{67}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(10\phi-2\theta^2-7\right)}{125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8}$$

Price:

$$\frac{25\alpha\phi^2-20\alpha\phi\theta^2-30\alpha\phi+16\alpha\theta^2+8\alpha+100\bar{c}\phi^2-20\bar{c}\phi\theta^2-70\bar{c}\phi}{125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8}$$

Firm Surplus:

$$\frac{4\phi\left(\alpha-\bar{c}\right)^2\cdot\left(625\phi^3-300\phi^2\theta^2-1000\phi^2+100\phi\theta^4+340\phi\theta^2+445\phi-64\theta^4-96\theta^2-32\right)}{\left(125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8\right)^2}$$

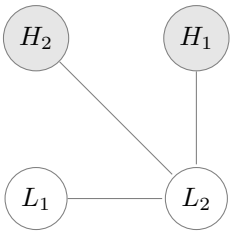
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(10\phi-2\theta^2-7\right)^2}{\left(125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8\right)^2}$$

Social Welfare:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(3750\phi^3-1600\phi^2\theta^2-5500\phi^2+300\phi\theta^4+1380\phi\theta^2+2115\phi-128\theta^4-192\theta^2-64\right)}{\left(125\phi^2-40\phi\theta^2-100\phi+16\theta^2+8\right)^2}$$

D.2.17 E3G [2H2L]



$$Equations: \begin{cases} e_1^H \cdot \left(\frac{25\phi}{3} - 3\right) = \alpha - 2e_2^H - 2e_1^L\theta + e_2^L\theta - \bar{c} \\ e_2^H \cdot \left(\frac{25\phi}{3} - 3\right) = \alpha - 2e_1^H - 2e_1^L\theta + e_2^L\theta - \bar{c} \\ e_1^L \cdot \left(\frac{25\phi}{3\theta} - 3\theta\right) = \alpha - 2e_1^H - 2e_2^H + e_2^L\theta - \bar{c} \\ e_2^L \cdot \left(\frac{25\phi}{\theta} - \theta\right) = \alpha + 3e_1^H + 3e_2^H + 3e_1^L\theta - \bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{15\phi(\alpha-\bar{c})\left(5\phi-3\theta^2\right)}{625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4} \\ e_2^H &= \frac{15\phi(\alpha-\bar{c})\left(5\phi-3\theta^2\right)}{625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4} \\ e_1^L &= \frac{15\phi\theta(\alpha-\bar{c})(5\phi-3)}{625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4} \\ e_2^L &= \frac{\theta(\alpha-\bar{c})\left(25\phi^2+15\phi-18\theta^2\right)}{625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{25\alpha\phi^2\theta^2+75\alpha\phi^2-30\alpha\phi\theta^2-18\alpha\theta^4-625\bar{c}\phi^3+225\bar{c}\phi^2\theta^2+90\bar{c}\phi\theta^2}{625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4} \\ c_2^H &= -\frac{25\alpha\phi^2\theta^2+75\alpha\phi^2-30\alpha\phi\theta^2-18\alpha\theta^4-625\bar{c}\phi^3+225\bar{c}\phi^2\theta^2+90\bar{c}\phi\theta^2}{625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4} \\ c_1^L &= -\frac{100\alpha\phi^2\theta^2-30\alpha\phi\theta^2-18\alpha\theta^4-625\bar{c}\phi^3+150\bar{c}\phi^2\theta^2+75\bar{c}\phi^2+90\bar{c}\phi\theta^2}{625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4} \\ c_2^L &= -\frac{100\alpha\phi^2\theta^2+150\alpha\phi^2-120\alpha\phi\theta^2-18\alpha\theta^4-625\bar{c}\phi^3+150\bar{c}\phi^2\theta^2-75\bar{c}\phi^2+180\bar{c}\phi\theta^2}{625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{25\phi^2(\alpha-\bar{c})\left(5\phi-3\theta^2\right)}{625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4} \\ q_2^H &= \frac{25\phi^2(\alpha-\bar{c})\left(5\phi-3\theta^2\right)}{625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4} \\ q_1^L &= \frac{25\phi^2(\alpha-\bar{c})(5\phi-3)}{625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4} \\ q_2^L &= \frac{5\phi(\alpha-\bar{c})\left(25\phi^2+15\phi-18\theta^2\right)}{625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{25\phi^3(\alpha-\bar{c})^2\left(5\phi-3\theta^2\right)^2\cdot(25\phi-9)}{(625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4)^2} \\ \pi_2^H &= \frac{25\phi^3(\alpha-\bar{c})^2\left(5\phi-3\theta^2\right)^2\cdot(25\phi-9)}{(625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4)^2} \\ \pi_1^L &= \frac{25\phi^3(\alpha-\bar{c})^2(5\phi-3)^2\cdot\left(25\phi-9\theta^2\right)}{(625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4)^2} \\ \pi_2^L &= \frac{\phi(\alpha-\bar{c})^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2+15\phi-18\theta^2\right)^2}{(625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4)^2} \end{cases} \tag{68}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(50\phi^2-15\phi\theta^2-9\theta^2\right)}{625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4}$$

Price:

$$\frac{125\alpha\phi^3-100\alpha\phi^2\theta^2-75\alpha\phi^2+30\alpha\phi\theta^2+18\alpha\theta^4+500\bar{c}\phi^3-150\bar{c}\phi^2\theta^2-90\bar{c}\phi\theta^2}{625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4}$$

Firm Surplus:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(31250\phi^5-21875\phi^4\theta^2-5625\phi^4+5625\phi^3\theta^4-1500\phi^3\theta^2+5625\phi^3-1575\phi^2\theta^4-7875\phi^2\theta^2+4320\phi\theta^4-162\theta^6\right)}{\left(625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4\right)^2}$$

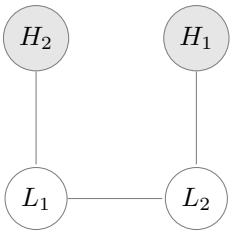
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(50\phi^2-15\phi\theta^2-9\theta^2\right)^2}{\left(625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4\right)^2}$$

Social Welfare:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(93750\phi^5-59375\phi^4\theta^2-5625\phi^4+11250\phi^3\theta^4-24000\phi^3\theta^2+5625\phi^3+5175\phi^2\theta^4-7875\phi^2\theta^2+6345\phi\theta^4-162\theta^6\right)}{\left(625\phi^3-250\phi^2\theta^2-75\phi^2-60\phi\theta^2+18\theta^4\right)^2}$$

D.2.18 E3H [2H2L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{3}-3\right)=\alpha-2e_2^H-3e_1^L\theta+2e_2^L\theta-\bar{c} \\ e_2^H\cdot\left(\frac{25\phi}{3}-3\right)=\alpha-2e_1^H+2e_1^L\theta-3e_2^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right)=\alpha-2e_1^H+3e_2^H+2e_2^L\theta-\bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right)=\alpha+3e_1^H-2e_2^H+2e_1^L\theta-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{3(\alpha-\bar{c})\left(5\phi-2\theta^2\right)}{125\phi^2-40\phi\theta^2-15\phi+6\theta^2} \\ e_2^H &= \frac{3(\alpha-\bar{c})\left(5\phi-2\theta^2\right)}{125\phi^2-40\phi\theta^2-15\phi+6\theta^2} \\ e_1^L &= \frac{10\phi\theta(\alpha-\bar{c})}{125\phi^2-40\phi\theta^2-15\phi+6\theta^2} \\ e_2^L &= \frac{10\phi\theta(\alpha-\bar{c})}{125\phi^2-40\phi\theta^2-15\phi+6\theta^2} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{10\alpha\phi\theta^2+15\alpha\phi-6\alpha\theta^2-125\bar{c}\phi^2+30\bar{c}\phi\theta^2}{125\phi^2-40\phi\theta^2-15\phi+6\theta^2} \\ c_2^H &= -\frac{10\alpha\phi\theta^2+15\alpha\phi-6\alpha\theta^2-125\bar{c}\phi^2+30\bar{c}\phi\theta^2}{125\phi^2-40\phi\theta^2-15\phi+6\theta^2} \\ c_1^L &= -\frac{20\alpha\phi\theta^2+15\alpha\phi-6\alpha\theta^2-125\bar{c}\phi^2+20\bar{c}\phi\theta^2}{125\phi^2-40\phi\theta^2-15\phi+6\theta^2} \\ c_2^L &= -\frac{20\alpha\phi\theta^2+15\alpha\phi-6\alpha\theta^2-125\bar{c}\phi^2+20\bar{c}\phi\theta^2}{125\phi^2-40\phi\theta^2-15\phi+6\theta^2} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-2\theta^2\right)}{125\phi^2-40\phi\theta^2-15\phi+6\theta^2} \\ q_2^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-2\theta^2\right)}{125\phi^2-40\phi\theta^2-15\phi+6\theta^2} \\ q_1^L &= \frac{25\phi^2(\alpha-\bar{c})}{125\phi^2-40\phi\theta^2-15\phi+6\theta^2} \\ q_2^L &= \frac{25\phi^2(\alpha-\bar{c})}{125\phi^2-40\phi\theta^2-15\phi+6\theta^2} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-2\theta^2\right)^2\cdot(25\phi-9)}{(125\phi^2-40\phi\theta^2-15\phi+6\theta^2)^2} \\ \pi_2^H &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-2\theta^2\right)^2\cdot(25\phi-9)}{(125\phi^2-40\phi\theta^2-15\phi+6\theta^2)^2} \\ \pi_1^L &= \frac{25\phi^3(\alpha-\bar{c})^2\cdot\left(25\phi-4\theta^2\right)}{(125\phi^2-40\phi\theta^2-15\phi+6\theta^2)^2} \\ \pi_2^L &= \frac{25\phi^3(\alpha-\bar{c})^2\cdot\left(25\phi-4\theta^2\right)}{(125\phi^2-40\phi\theta^2-15\phi+6\theta^2)^2} \end{cases} \tag{69}$$

Total Production:

$$\frac{20\phi\left(\alpha-\bar{c}\right)\left(5\phi-\theta^2\right)}{125\phi^2-40\phi\theta^2-15\phi+6\theta^2}$$

Price:

$$\frac{25\alpha\phi^2-20\alpha\phi\theta^2-15\alpha\phi+6\alpha\theta^2+100\bar{c}\phi^2-20\bar{c}\phi\theta^2}{125\phi^2-40\phi\theta^2-15\phi+6\theta^2}$$

Firm Surplus:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(1250\phi^3-600\phi^2\theta^2-225\phi^2+100\phi\theta^4+180\phi\theta^2-36\theta^4\right)}{\left(125\phi^2-40\phi\theta^2-15\phi+6\theta^2\right)^2}$$

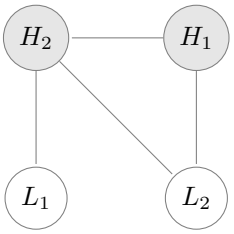
Consumer Surplus:

$$\frac{200\phi^2\left(\alpha-\bar{c}\right)^2\left(5\phi-\theta^2\right)^2}{\left(125\phi^2-40\phi\theta^2-15\phi+6\theta^2\right)^2}$$

Social Welfare:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(3750\phi^3-1600\phi^2\theta^2-225\phi^2+200\phi\theta^4+180\phi\theta^2-36\theta^4\right)}{\left(125\phi^2-40\phi\theta^2-15\phi+6\theta^2\right)^2}$$

D.2.19 E4A [2H2L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{2}-2\right)=\alpha+e_2^H-2e_1^L\theta+2e_2^L\theta-\bar{c} \\ e_2^H\cdot(25\phi-1)=\alpha+2e_1^H+3e_1^L\theta+2e_2^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right)=\alpha-3e_1^H+e_2^H-3e_2^L\theta-\bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right)=\alpha+2e_1^H+e_2^H-2e_1^L\theta-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{10\phi(\alpha-\bar{c})\left(5\phi-3\theta^2\right)}{625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2} \\ e_2^H &= \frac{(\alpha-\bar{c})\left(25\phi^2-6\theta^4-6\theta^2\right)}{625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2} \\ e_1^L &= \frac{15\phi\theta(\alpha-\bar{c})\left(5\phi-2\theta^2-2\right)}{625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2} \\ e_2^L &= \frac{10\phi\theta(\alpha-\bar{c})\left(5\phi-3\theta^2\right)}{625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{50\alpha\phi^2\theta^2+75\alpha\phi^2-30\alpha\phi\theta^4-30\alpha\phi\theta^2-6\alpha\theta^4-6\alpha\theta^2-625\bar{c}\phi^3+275\bar{c}\phi^2\theta^2+50\bar{c}\phi^2+30\bar{c}\phi\theta^4+30\bar{c}\phi\theta^2}{625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2} \\ c_2^H &= -\frac{125\alpha\phi^2\theta^2+75\alpha\phi^2-60\alpha\phi\theta^4-60\alpha\phi\theta^2-6\alpha\theta^4-6\alpha\theta^2-625\bar{c}\phi^3+200\bar{c}\phi^2\theta^2+50\bar{c}\phi^2+60\bar{c}\phi\theta^4+60\bar{c}\phi\theta^2}{625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2} \\ c_1^L &= -\frac{75\alpha\phi^2\theta^2+25\alpha\phi^2-30\alpha\phi\theta^4-30\alpha\phi\theta^2-6\alpha\theta^4-6\alpha\theta^2-625\bar{c}\phi^3+250\bar{c}\phi^2\theta^2+100\bar{c}\phi^2+30\bar{c}\phi\theta^4+30\bar{c}\phi\theta^2}{625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2} \\ c_2^L &= -\frac{50\alpha\phi^2\theta^2+75\alpha\phi^2-30\alpha\phi\theta^4-30\alpha\phi\theta^2-6\alpha\theta^4-6\alpha\theta^2-625\bar{c}\phi^3+275\bar{c}\phi^2\theta^2+50\bar{c}\phi^2+30\bar{c}\phi\theta^4+30\bar{c}\phi\theta^2}{625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{25\phi^2(\alpha-\bar{c})\left(5\phi-3\theta^2\right)}{625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2} \\ q_2^H &= \frac{5\phi(\alpha-\bar{c})\left(25\phi^2-6\theta^4-6\theta^2\right)}{625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2} \\ q_1^L &= \frac{25\phi^2(\alpha-\bar{c})\left(5\phi-2\theta^2-2\right)}{625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2} \\ q_2^L &= \frac{25\phi^2(\alpha-\bar{c})\left(5\phi-3\theta^2\right)}{625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{25\phi^3(\alpha-\bar{c})^2\left(5\phi-3\theta^2\right)^2\cdot(25\phi-4)}{(625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2)^2} \\ \pi_2^H &= \frac{\phi(\alpha-\bar{c})^2\cdot(25\phi-1)\left(25\phi^2-6\theta^4-6\theta^2\right)^2}{(625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2)^2} \\ \pi_1^L &= \frac{25\phi^3(\alpha-\bar{c})^2\cdot\left(25\phi-9\theta^2\right)\left(5\phi-2\theta^2-2\right)^2}{(625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2)^2} \\ \pi_2^L &= \frac{25\phi^3(\alpha-\bar{c})^2\left(5\phi-3\theta^2\right)^2\cdot\left(25\phi-4\theta^2\right)}{(625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2)^2} \end{cases} \tag{70}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(50\phi^2-20\phi\theta^2-5\phi-3\theta^4-3\theta^2\right)}{625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2}$$

Price:

$$\frac{125\alpha\phi^3-125\alpha\phi^2\theta^2-75\alpha\phi^2+30\alpha\phi\theta^4+30\alpha\phi\theta^2+6\alpha\theta^4+6\alpha\theta^2+500\bar{c}\phi^3-200\bar{c}\phi^2\theta^2-50\bar{c}\phi^2-30\bar{c}\phi\theta^4-30\bar{c}\phi\theta^2}{625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2}$$

Firm Surplus:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(62500\phi^5-58125\phi^4\theta^2-15625\phi^4+13750\phi^3\theta^4+5000\phi^3\theta^2+2500\phi^3-1800\phi^2\theta^6-2400\phi^2\theta^4-600\phi^2\theta^2+900\phi\theta^8+1800\phi\theta^6+900\phi\theta^4-36\theta^8-72\theta^6-36\theta^4\right)}{\left(625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2\right)^2}$$

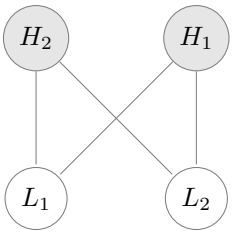
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(50\phi^2-20\phi\theta^2-5\phi-3\theta^4-3\theta^2\right)^2}{\left(625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2\right)^2}$$

Social Welfare:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(187500\phi^5-158125\phi^4\theta^2-40625\phi^4+18750\phi^3\theta^4+3750\phi^3+4200\phi^2\theta^6+5100\phi^2\theta^4+900\phi^2\theta^2+1350\phi\theta^8+2700\phi\theta^6+1350\phi\theta^4-36\theta^8-72\theta^6-36\theta^4\right)}{\left(625\phi^3-325\phi^2\theta^2-125\phi^2+6\theta^4+6\theta^2\right)^2}$$

D.2.20 E4B [2H2L]



$$Equations:\begin{cases}e_1^H\cdot\left(\frac{25\phi}{2}-2\right)=\alpha-3e_2^H+2e_1^L\theta+2e_2^L\theta-\bar{c}\\e_2^H\cdot\left(\frac{25\phi}{2}-2\right)=\alpha-3e_1^H+2e_1^L\theta+2e_2^L\theta-\bar{c}\\e_1^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right)=\alpha+2e_1^H+2e_2^H-3e_2^L\theta-\bar{c}\\e_2^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right)=\alpha+2e_1^H+2e_2^H-3e_1^L\theta-\bar{c}\end{cases}$$

Optimal efforts:

$$\begin{cases}e_1^H&=\frac{2(\alpha-\bar{c})\left(5\phi+2\theta^2\right)}{125\phi^2+10\phi\theta^2+10\phi-12\theta^2}\\e_2^H&=\frac{2(\alpha-\bar{c})\left(5\phi+2\theta^2\right)}{125\phi^2+10\phi\theta^2+10\phi-12\theta^2}\\e_1^L&=\frac{2\theta(\alpha-\bar{c})(5\phi+2)}{125\phi^2+10\phi\theta^2+10\phi-12\theta^2}\\e_2^L&=\frac{2\theta(\alpha-\bar{c})(5\phi+2)}{125\phi^2+10\phi\theta^2+10\phi-12\theta^2}\end{cases}$$

Production Costs:

$$\begin{cases}c_1^H&=-\frac{20\alpha\phi\theta^2+10\alpha\phi+12\alpha\theta^2-125\bar{c}\phi^2-30\bar{c}\phi\theta^2-20\bar{c}\phi}{125\phi^2+10\phi\theta^2+10\phi-12\theta^2}\\c_2^H&=-\frac{20\alpha\phi\theta^2+10\alpha\phi+12\alpha\theta^2-125\bar{c}\phi^2-30\bar{c}\phi\theta^2-20\bar{c}\phi}{125\phi^2+10\phi\theta^2+10\phi-12\theta^2}\\c_1^L&=-\frac{10\alpha\phi\theta^2+20\alpha\phi+12\alpha\theta^2-125\bar{c}\phi^2-20\bar{c}\phi\theta^2-30\bar{c}\phi}{125\phi^2+10\phi\theta^2+10\phi-12\theta^2}\\c_2^L&=-\frac{10\alpha\phi\theta^2+20\alpha\phi+12\alpha\theta^2-125\bar{c}\phi^2-20\bar{c}\phi\theta^2-30\bar{c}\phi}{125\phi^2+10\phi\theta^2+10\phi-12\theta^2}\end{cases}$$

Production Quantities:

$$\begin{cases}q_1^H&=\frac{5\phi(\alpha-\bar{c})\left(5\phi+2\theta^2\right)}{125\phi^2+10\phi\theta^2+10\phi-12\theta^2}\\q_2^H&=\frac{5\phi(\alpha-\bar{c})\left(5\phi+2\theta^2\right)}{125\phi^2+10\phi\theta^2+10\phi-12\theta^2}\\q_1^L&=\frac{5\phi(\alpha-\bar{c})(5\phi+2)}{125\phi^2+10\phi\theta^2+10\phi-12\theta^2}\\q_2^L&=\frac{5\phi(\alpha-\bar{c})(5\phi+2)}{125\phi^2+10\phi\theta^2+10\phi-12\theta^2}\end{cases}$$

Profits:

$$\begin{cases}\pi_1^H&=\frac{\phi(\alpha-\bar{c})^2\left(5\phi+2\theta^2\right)^2\cdot(25\phi-4)}{(125\phi^2+10\phi\theta^2+10\phi-12\theta^2)^2}\\\pi_2^H&=\frac{\phi(\alpha-\bar{c})^2\left(5\phi+2\theta^2\right)^2\cdot(25\phi-4)}{(125\phi^2+10\phi\theta^2+10\phi-12\theta^2)^2}\\\pi_1^L&=\frac{\phi(\alpha-\bar{c})^2(5\phi+2)^2\cdot\left(25\phi-4\theta^2\right)}{(125\phi^2+10\phi\theta^2+10\phi-12\theta^2)^2}\\\pi_2^L&=\frac{\phi(\alpha-\bar{c})^2(5\phi+2)^2\cdot\left(25\phi-4\theta^2\right)}{(125\phi^2+10\phi\theta^2+10\phi-12\theta^2)^2}\end{cases}\tag{71}$$

Total Production:

$$\frac{20\phi\left(\alpha-\bar{c}\right)\left(5\phi+\theta^2+1\right)}{125\phi^2+10\phi\theta^2+10\phi-12\theta^2}$$

Price:

$$\frac{25\alpha\phi^2-10\alpha\phi\theta^2-10\alpha\phi-12\alpha\theta^2+100\bar{c}\phi^2+20\bar{c}\phi\theta^2+20\bar{c}\phi}{125\phi^2+10\phi\theta^2+10\phi-12\theta^2}$$

Firm Surplus:

$$\frac{4\phi\left(\alpha-\bar{c}\right)^2\cdot\left(625\phi^3+200\phi^2\theta^2+200\phi^2+50\phi\theta^4-80\phi\theta^2+50\phi-8\theta^4-8\theta^2\right)}{\left(125\phi^2+10\phi\theta^2+10\phi-12\theta^2\right)^2}$$

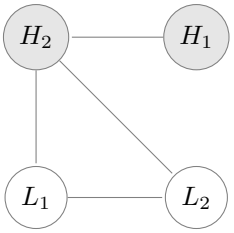
Consumer Surplus:

$$\frac{200\phi^2\left(\alpha-\bar{c}\right)^2\left(5\phi+\theta^2+1\right)^2}{\left(125\phi^2+10\phi\theta^2+10\phi-12\theta^2\right)^2}$$

Social Welfare:

$$\frac{4\phi\left(\alpha-\bar{c}\right)^2\cdot\left(1875\phi^3+700\phi^2\theta^2+700\phi^2+100\phi\theta^4+20\phi\theta^2+100\phi-8\theta^4-8\theta^2\right)}{\left(125\phi^2+10\phi\theta^2+10\phi-12\theta^2\right)^2}$$

D.2.21 E4C [2H2L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{3}-3\right)=\alpha+e_2^H-3e_1^L\theta-3e_2^L\theta-\bar{c} \\ e_2^H\cdot(25\phi-1)=\alpha+3e_1^H+2e_1^L\theta+2e_2^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right)=\alpha-2e_1^H+e_2^H+2e_2^L\theta-\bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right)=\alpha-2e_1^H+e_2^H+2e_1^L\theta-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{15\phi(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2} \\ e_2^H &= \frac{(\alpha-\bar{c})\left(25\phi^2-12\theta^2\right)}{625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2} \\ e_1^L &= \frac{10\phi\theta(\alpha-\bar{c})(5\phi-3)}{625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2} \\ e_2^L &= \frac{10\phi\theta(\alpha-\bar{c})(5\phi-3)}{625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{100\alpha\phi^2-60\alpha\phi\theta^2-12\alpha\theta^2-625\bar{c}\phi^3+200\bar{c}\phi^2\theta^2+150\bar{c}\phi^2+60\bar{c}\phi\theta^2}{625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2} \\ c_2^H &= -\frac{100\alpha\phi^2\theta^2+100\alpha\phi^2-120\alpha\phi\theta^2-12\alpha\theta^2-625\bar{c}\phi^3+100\bar{c}\phi^2\theta^2+150\bar{c}\phi^2+120\bar{c}\phi\theta^2}{625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2} \\ c_1^L &= -\frac{100\alpha\phi^2\theta^2+25\alpha\phi^2-60\alpha\phi\theta^2-12\alpha\theta^2-625\bar{c}\phi^3+100\bar{c}\phi^2\theta^2+225\bar{c}\phi^2+60\bar{c}\phi\theta^2}{625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2} \\ c_2^L &= -\frac{100\alpha\phi^2\theta^2+25\alpha\phi^2-60\alpha\phi\theta^2-12\alpha\theta^2-625\bar{c}\phi^3+100\bar{c}\phi^2\theta^2+225\bar{c}\phi^2+60\bar{c}\phi\theta^2}{625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{25\phi^2(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2} \\ q_2^H &= \frac{5\phi(\alpha-\bar{c})\left(25\phi^2-12\theta^2\right)}{625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2} \\ q_1^L &= \frac{25\phi^2(\alpha-\bar{c})(5\phi-3)}{625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2} \\ q_2^L &= \frac{25\phi^2(\alpha-\bar{c})(5\phi-3)}{625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{25\phi^3(\alpha-\bar{c})^2\left(5\phi-4\theta^2\right)^2\cdot(25\phi-9)}{(625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2)^2} \\ \pi_2^H &= \frac{\phi(\alpha-\bar{c})^2\cdot(25\phi-1)\left(25\phi^2-12\theta^2\right)^2}{(625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2)^2} \\ \pi_1^L &= \frac{25\phi^3(\alpha-\bar{c})^2(5\phi-3)^2\cdot\left(25\phi-4\theta^2\right)}{(625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2)^2} \\ \pi_2^L &= \frac{25\phi^3(\alpha-\bar{c})^2(5\phi-3)^2\cdot\left(25\phi-4\theta^2\right)}{(625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2)^2} \end{cases} \tag{72}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(50\phi^2-10\phi\theta^2-15\phi-6\theta^2\right)}{625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2}$$

Price:

$$\frac{125\alpha\phi^3-100\alpha\phi^2\theta^2-100\alpha\phi^2+60\alpha\phi\theta^2+12\alpha\theta^2+500\bar{c}\phi^3-100\bar{c}\phi^2\theta^2-150\bar{c}\phi^2-60\bar{c}\phi\theta^2}{625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2}$$

Firm Surplus:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(31250\phi^5-15000\phi^4\theta^2-21875\phi^4+5000\phi^3\theta^4+5625\phi^3-1800\phi^2\theta^4-600\phi^2\theta^2+1800\phi\theta^4-72\theta^4\right)}{\left(625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2\right)^2}$$

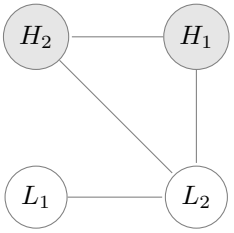
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(50\phi^2-10\phi\theta^2-15\phi-6\theta^2\right)^2}{\left(625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2\right)^2}$$

Social Welfare:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(93750\phi^5-40000\phi^4\theta^2-59375\phi^4+7500\phi^3\theta^4-7500\phi^3\theta^2+11250\phi^3+1200\phi^2\theta^4+3900\phi^2\theta^2+2700\phi\theta^4-72\theta^4\right)}{\left(625\phi^3-200\phi^2\theta^2-250\phi^2+12\theta^2\right)^2}$$

D.2.22 E4D [2H2L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{2}-2\right)=\alpha+2e_2^H-2e_1^L\theta+e_2^L\theta-\bar{c} \\ e_2^H\cdot\left(\frac{25\phi}{2}-2\right)=\alpha+2e_1^H-2e_1^L\theta+e_2^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right)=\alpha-3e_1^H-3e_2^H+e_2^L\theta-\bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{\theta}-\theta\right)=\alpha+2e_1^H+2e_2^H+3e_1^L\theta-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{10\phi(\alpha-\bar{c})\left(5\phi-3\theta^2\right)}{625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4} \\ e_2^H &= \frac{10\phi(\alpha-\bar{c})\left(5\phi-3\theta^2\right)}{625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4} \\ e_1^L &= \frac{15\phi\theta(\alpha-\bar{c})(5\phi-4)}{625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4} \\ e_2^L &= \frac{\theta(\alpha-\bar{c})\left(25\phi^2-12\theta^2\right)}{625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{25\alpha\phi^2\theta^2+100\alpha\phi^2-60\alpha\phi\theta^2-12\alpha\theta^4-625\bar{c}\phi^3+225\bar{c}\phi^2\theta^2+100\bar{c}\phi^2+60\bar{c}\phi\theta^2}{625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4} \\ c_2^H &= -\frac{25\alpha\phi^2\theta^2+100\alpha\phi^2-60\alpha\phi\theta^2-12\alpha\theta^4-625\bar{c}\phi^3+225\bar{c}\phi^2\theta^2+100\bar{c}\phi^2+60\bar{c}\phi\theta^2}{625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4} \\ c_1^L &= -\frac{100\alpha\phi^2\theta^2-60\alpha\phi\theta^2-12\alpha\theta^4-625\bar{c}\phi^3+150\bar{c}\phi^2\theta^2+200\bar{c}\phi^2+60\bar{c}\phi\theta^2}{625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4} \\ c_2^L &= -\frac{100\alpha\phi^2\theta^2+100\alpha\phi^2-120\alpha\phi\theta^2-12\alpha\theta^4-625\bar{c}\phi^3+150\bar{c}\phi^2\theta^2+100\bar{c}\phi^2+120\bar{c}\phi\theta^2}{625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{25\phi^2(\alpha-\bar{c})\left(5\phi-3\theta^2\right)}{625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4} \\ q_2^H &= \frac{25\phi^2(\alpha-\bar{c})\left(5\phi-3\theta^2\right)}{625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4} \\ q_1^L &= \frac{25\phi^2(\alpha-\bar{c})(5\phi-4)}{625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4} \\ q_2^L &= \frac{5\phi(\alpha-\bar{c})\left(25\phi^2-12\theta^2\right)}{625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{25\phi^3(\alpha-\bar{c})^2\left(5\phi-3\theta^2\right)^2\cdot(25\phi-4)}{(625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4)^2} \\ \pi_2^H &= \frac{25\phi^3(\alpha-\bar{c})^2\left(5\phi-3\theta^2\right)^2\cdot(25\phi-4)}{(625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4)^2} \\ \pi_1^L &= \frac{25\phi^3(\alpha-\bar{c})^2(5\phi-4)^2\cdot\left(25\phi-9\theta^2\right)}{(625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4)^2} \\ \pi_2^L &= \frac{\phi(\alpha-\bar{c})^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2-12\theta^2\right)^2}{(625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4)^2} \end{cases} \tag{73}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(50\phi^2-15\phi\theta^2-10\phi-6\theta^2\right)}{625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4}$$

Price:

$$\frac{125\alpha\phi^3-100\alpha\phi^2\theta^2-100\alpha\phi^2+60\alpha\phi\theta^2+12\alpha\theta^4+500\bar{c}\phi^3-150\bar{c}\phi^2\theta^2-100\bar{c}\phi^2-60\bar{c}\phi\theta^2}{625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4}$$

Firm Surplus:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(31250\phi^5-21875\phi^4\theta^2-15000\phi^4+5625\phi^3\theta^4+5000\phi^3-600\phi^2\theta^4-1800\phi^2\theta^2+1800\phi\theta^4-72\theta^6\right)}{\left(625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4\right)^2}$$

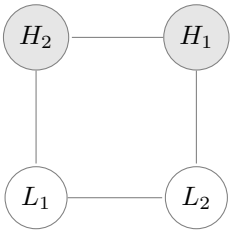
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(50\phi^2-15\phi\theta^2-10\phi-6\theta^2\right)^2}{\left(625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4\right)^2}$$

Social Welfare:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(93750\phi^5-59375\phi^4\theta^2-40000\phi^4+11250\phi^3\theta^4-7500\phi^3\theta^2+7500\phi^3+3900\phi^2\theta^4+1200\phi^2\theta^2+2700\phi\theta^4-72\theta^6\right)}{\left(625\phi^3-250\phi^2\theta^2-200\phi^2+12\theta^4\right)^2}$$

D.2.23 E4E [2H2L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{2}-2\right)=\alpha+2e_2^H-3e_1^L\theta+2e_2^L\theta-\bar{c} \\ e_2^H\cdot\left(\frac{25\phi}{2}-2\right)=\alpha+2e_1^H+2e_1^L\theta-3e_2^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right)=\alpha-3e_1^H+2e_2^H+2e_2^L\theta-\bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right)=\alpha+2e_1^H-3e_2^H+2e_1^L\theta-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{2(\alpha-\bar{c})\left(5\phi-2\theta^2\right)}{125\phi^2-40\phi\theta^2-40\phi+12\theta^2} \\ e_2^H &= \frac{2(\alpha-\bar{c})\left(5\phi-2\theta^2\right)}{125\phi^2-40\phi\theta^2-40\phi+12\theta^2} \\ e_1^L &= \frac{2\theta(\alpha-\bar{c})(5\phi-2)}{125\phi^2-40\phi\theta^2-40\phi+12\theta^2} \\ e_2^L &= \frac{2\theta(\alpha-\bar{c})(5\phi-2)}{125\phi^2-40\phi\theta^2-40\phi+12\theta^2} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{10\alpha\phi\theta^2+20\alpha\phi-12\alpha\theta^2-125\bar{c}\phi^2+30\bar{c}\phi\theta^2+20\bar{c}\phi}{125\phi^2-40\phi\theta^2-40\phi+12\theta^2} \\ c_2^H &= -\frac{10\alpha\phi\theta^2+20\alpha\phi-12\alpha\theta^2-125\bar{c}\phi^2+30\bar{c}\phi\theta^2+20\bar{c}\phi}{125\phi^2-40\phi\theta^2-40\phi+12\theta^2} \\ c_1^L &= -\frac{20\alpha\phi\theta^2+10\alpha\phi-12\alpha\theta^2-125\bar{c}\phi^2+20\bar{c}\phi\theta^2+30\bar{c}\phi}{125\phi^2-40\phi\theta^2-40\phi+12\theta^2} \\ c_2^L &= -\frac{20\alpha\phi\theta^2+10\alpha\phi-12\alpha\theta^2-125\bar{c}\phi^2+20\bar{c}\phi\theta^2+30\bar{c}\phi}{125\phi^2-40\phi\theta^2-40\phi+12\theta^2} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-2\theta^2\right)}{125\phi^2-40\phi\theta^2-40\phi+12\theta^2} \\ q_2^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-2\theta^2\right)}{125\phi^2-40\phi\theta^2-40\phi+12\theta^2} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-2)}{125\phi^2-40\phi\theta^2-40\phi+12\theta^2} \\ q_2^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-2)}{125\phi^2-40\phi\theta^2-40\phi+12\theta^2} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-2\theta^2\right)^2\cdot(25\phi-4)}{(125\phi^2-40\phi\theta^2-40\phi+12\theta^2)^2} \\ \pi_2^H &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-2\theta^2\right)^2\cdot(25\phi-4)}{(125\phi^2-40\phi\theta^2-40\phi+12\theta^2)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-2)^2\cdot\left(25\phi-4\theta^2\right)}{(125\phi^2-40\phi\theta^2-40\phi+12\theta^2)^2} \\ \pi_2^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-2)^2\cdot\left(25\phi-4\theta^2\right)}{(125\phi^2-40\phi\theta^2-40\phi+12\theta^2)^2} \end{cases} \tag{74}$$

Total Production:

$$\frac{20\phi\left(\alpha-\bar{c}\right)\left(5\phi-\theta^2-1\right)}{125\phi^2-40\phi\theta^2-40\phi+12\theta^2}$$

Price:

$$\frac{25\alpha\phi^2-20\alpha\phi\theta^2-20\alpha\phi+12\alpha\theta^2+100\bar{c}\phi^2-20\bar{c}\phi\theta^2-20\bar{c}\phi}{125\phi^2-40\phi\theta^2-40\phi+12\theta^2}$$

Firm Surplus:

$$\frac{4\phi\left(\alpha-\bar{c}\right)^2\cdot\left(625\phi^3-300\phi^2\theta^2-300\phi^2+50\phi\theta^4+80\phi\theta^2+50\phi-8\theta^4-8\theta^2\right)}{\left(125\phi^2-40\phi\theta^2-40\phi+12\theta^2\right)^2}$$

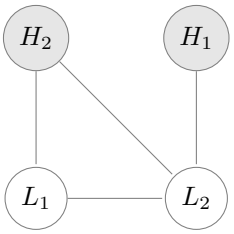
Consumer Surplus:

$$\frac{200\phi^2\left(\alpha-\bar{c}\right)^2\left(5\phi-\theta^2-1\right)^2}{\left(125\phi^2-40\phi\theta^2-40\phi+12\theta^2\right)^2}$$

Social Welfare:

$$\frac{4\phi\left(\alpha-\bar{c}\right)^2\cdot\left(1875\phi^3-800\phi^2\theta^2-800\phi^2+100\phi\theta^4+180\phi\theta^2+100\phi-8\theta^4-8\theta^2\right)}{\left(125\phi^2-40\phi\theta^2-40\phi+12\theta^2\right)^2}$$

D.2.24 E4F [2H2L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{3}-3\right)=\alpha-3e_2^H-3e_1^L\theta+e_2^L\theta-\bar{c} \\ e_2^H\cdot\left(\frac{25\phi}{2}-2\right)=\alpha-2e_1^H+2e_1^L\theta+e_2^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right)=\alpha-2e_1^H+2e_2^H+e_2^L\theta-\bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{\theta}-\theta\right)=\alpha+3e_1^H+2e_2^H+2e_1^L\theta-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{15\phi(\alpha-\bar{c})\left(5\phi-2\theta^2-2\right)}{625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2} \\ e_2^H &= \frac{10\phi(\alpha-\bar{c})(5\phi-3)}{625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2} \\ e_1^L &= \frac{10\phi\theta(\alpha-\bar{c})(5\phi-3)}{625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2} \\ e_2^L &= \frac{\theta(\alpha-\bar{c})\left(25\phi^2-6\theta^2-6\right)}{625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{25\alpha\phi^2\theta^2+75\alpha\phi^2-30\alpha\phi\theta^2-30\alpha\phi-6\alpha\theta^4-6\alpha\theta^2-625\bar{c}\phi^3+100\bar{c}\phi^2\theta^2+250\bar{c}\phi^2+30\bar{c}\phi\theta^2+30\bar{c}\phi}{625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2} \\ c_2^H &= -\frac{75\alpha\phi^2\theta^2+50\alpha\phi^2-30\alpha\phi\theta^2-30\alpha\phi-6\alpha\theta^4-6\alpha\theta^2-625\bar{c}\phi^3+50\bar{c}\phi^2\theta^2+275\bar{c}\phi^2+30\bar{c}\phi\theta^2+30\bar{c}\phi}{625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2} \\ c_1^L &= -\frac{75\alpha\phi^2\theta^2+50\alpha\phi^2-30\alpha\phi\theta^2-30\alpha\phi-6\alpha\theta^4-6\alpha\theta^2-625\bar{c}\phi^3+50\bar{c}\phi^2\theta^2+275\bar{c}\phi^2+30\bar{c}\phi\theta^2+30\bar{c}\phi}{625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2} \\ c_2^L &= -\frac{75\alpha\phi^2\theta^2+125\alpha\phi^2-60\alpha\phi\theta^2-60\alpha\phi-6\alpha\theta^4-6\alpha\theta^2-625\bar{c}\phi^3+50\bar{c}\phi^2\theta^2+200\bar{c}\phi^2+60\bar{c}\phi\theta^2+60\bar{c}\phi}{625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{25\phi^2(\alpha-\bar{c})\left(5\phi-2\theta^2-2\right)}{625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2} \\ q_2^H &= \frac{25\phi^2(\alpha-\bar{c})(5\phi-3)}{625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2} \\ q_1^L &= \frac{25\phi^2(\alpha-\bar{c})(5\phi-3)}{625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2} \\ q_2^L &= \frac{5\phi(\alpha-\bar{c})\left(25\phi^2-6\theta^2-6\right)}{625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{25\phi^3(\alpha-\bar{c})^2\cdot(25\phi-9)\left(5\phi-2\theta^2-2\right)^2}{(625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2)^2} \\ \pi_2^H &= \frac{25\phi^3(\alpha-\bar{c})^2(5\phi-3)^2\cdot(25\phi-4)}{(625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2)^2} \\ \pi_1^L &= \frac{25\phi^3(\alpha-\bar{c})^2(5\phi-3)^2\cdot\left(25\phi-4\theta^2\right)}{(625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2)^2} \\ \pi_2^L &= \frac{\phi(\alpha-\bar{c})^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2-6\theta^2-6\right)^2}{(625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2)^2} \end{cases} \tag{75}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(50\phi^2-5\phi\theta^2-20\phi-3\theta^2-3\right)}{625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2}$$

Price:

$$\frac{125\alpha\phi^3-75\alpha\phi^2\theta^2-125\alpha\phi^2+30\alpha\phi\theta^2+30\alpha\phi+6\alpha\theta^4+6\alpha\theta^2+500\bar{c}\phi^3-50\bar{c}\phi^2\theta^2-200\bar{c}\phi^2-30\bar{c}\phi\theta^2-30\bar{c}\phi}{625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2}$$

Firm Surplus:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(62500\phi^5-15625\phi^4\theta^2-58125\phi^4+2500\phi^3\theta^4+5000\phi^3\theta^2+13750\phi^3-600\phi^2\theta^4-2400\phi^2\theta^2-1800\phi^2+900\phi\theta^4+1800\phi\theta^2+900\phi-36\theta^6-72\theta^4-36\theta^2\right)}{\left(625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2\right)^2}$$

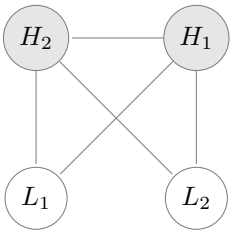
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(50\phi^2-5\phi\theta^2-20\phi-3\theta^2-3\right)^2}{\left(625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2\right)^2}$$

Social Welfare:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(187500\phi^5-40625\phi^4\theta^2-158125\phi^4+3750\phi^3\theta^4+18750\phi^3+900\phi^2\theta^4+5100\phi^2\theta^2+4200\phi^2+1350\phi\theta^4+2700\phi\theta^2+1350\phi-36\theta^6-72\theta^4-36\theta^2\right)}{\left(625\phi^3-125\phi^2\theta^2-325\phi^2+6\theta^4+6\theta^2\right)^2}$$

D.2.25 E5A [2H2L]



$$Equations: \begin{cases} e_1^H\cdot(25\phi-1) = \alpha + e_2^H + 2e_1^L\theta + 2e_2^L\theta - \bar{c} \\ e_2^H\cdot(25\phi-1) = \alpha + e_1^H + 2e_1^L\theta + 2e_2^L\theta - \bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right) = \alpha + e_1^H + e_2^H - 3e_2^L\theta - \bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right) = \alpha + e_1^H + e_2^H - 3e_1^L\theta - \bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{(\alpha-\bar{c})\left(5\phi+2\theta^2\right)}{125\phi^2+10\phi\theta^2-10\phi-4\theta^2} \\ e_2^H &= \frac{(\alpha-\bar{c})\left(5\phi+2\theta^2\right)}{125\phi^2+10\phi\theta^2-10\phi-4\theta^2} \\ e_1^L &= \frac{10\phi\theta(\alpha-\bar{c})}{125\phi^2+10\phi\theta^2-10\phi-4\theta^2} \\ e_2^L &= \frac{10\phi\theta(\alpha-\bar{c})}{125\phi^2+10\phi\theta^2-10\phi-4\theta^2} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{20\alpha\phi\theta^2+10\alpha\phi+4\alpha\theta^2-125\bar{c}\phi^2-30\bar{c}\phi\theta^2}{125\phi^2+10\phi\theta^2-10\phi-4\theta^2} \\ c_2^H &= -\frac{20\alpha\phi\theta^2+10\alpha\phi+4\alpha\theta^2-125\bar{c}\phi^2-30\bar{c}\phi\theta^2}{125\phi^2+10\phi\theta^2-10\phi-4\theta^2} \\ c_1^L &= -\frac{10\alpha\phi\theta^2+10\alpha\phi+4\alpha\theta^2-125\bar{c}\phi^2-20\bar{c}\phi\theta^2}{125\phi^2+10\phi\theta^2-10\phi-4\theta^2} \\ c_2^L &= -\frac{10\alpha\phi\theta^2+10\alpha\phi+4\alpha\theta^2-125\bar{c}\phi^2-20\bar{c}\phi\theta^2}{125\phi^2+10\phi\theta^2-10\phi-4\theta^2} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi+2\theta^2\right)}{125\phi^2+10\phi\theta^2-10\phi-4\theta^2} \\ q_2^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi+2\theta^2\right)}{125\phi^2+10\phi\theta^2-10\phi-4\theta^2} \\ q_1^L &= \frac{25\phi^2(\alpha-\bar{c})}{125\phi^2+10\phi\theta^2-10\phi-4\theta^2} \\ q_2^L &= \frac{25\phi^2(\alpha-\bar{c})}{125\phi^2+10\phi\theta^2-10\phi-4\theta^2} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi+2\theta^2\right)^2\cdot(25\phi-1)}{(125\phi^2+10\phi\theta^2-10\phi-4\theta^2)^2} \\ \pi_2^H &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi+2\theta^2\right)^2\cdot(25\phi-1)}{(125\phi^2+10\phi\theta^2-10\phi-4\theta^2)^2} \\ \pi_1^L &= \frac{25\phi^3(\alpha-\bar{c})^2\cdot\left(25\phi-4\theta^2\right)}{(125\phi^2+10\phi\theta^2-10\phi-4\theta^2)^2} \\ \pi_2^L &= \frac{25\phi^3(\alpha-\bar{c})^2\cdot\left(25\phi-4\theta^2\right)}{(125\phi^2+10\phi\theta^2-10\phi-4\theta^2)^2} \end{cases} \tag{76}$$

Total Production:

$$\frac{20\phi\left(\alpha-\bar{c}\right)\left(5\phi+\theta^2\right)}{125\phi^2+10\phi\theta^2-10\phi-4\theta^2}$$

Price:

$$\frac{25\alpha\phi^2-10\alpha\phi\theta^2-10\alpha\phi-4\alpha\theta^2+100\bar{c}\phi^2+20\bar{c}\phi\theta^2}{125\phi^2+10\phi\theta^2-10\phi-4\theta^2}$$

Firm Surplus:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(1250\phi^3+400\phi^2\theta^2-25\phi^2+100\phi\theta^4-20\phi\theta^2-4\theta^4\right)}{\left(125\phi^2+10\phi\theta^2-10\phi-4\theta^2\right)^2}$$

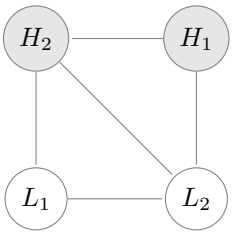
Consumer Surplus:

$$\frac{200\phi^2\left(\alpha-\bar{c}\right)^2\left(5\phi+\theta^2\right)^2}{\left(125\phi^2+10\phi\theta^2-10\phi-4\theta^2\right)^2}$$

Social Welfare:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(3750\phi^3+1400\phi^2\theta^2-25\phi^2+200\phi\theta^4-20\phi\theta^2-4\theta^4\right)}{\left(125\phi^2+10\phi\theta^2-10\phi-4\theta^2\right)^2}$$

D.2.26 E5B [2H2L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{2}-2\right)=\alpha+e_2^H-3e_1^L\theta+e_2^L\theta-\bar{c} \\ e_2^H\cdot(25\phi-1)=\alpha+2e_1^H+2e_1^L\theta+e_2^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right)=\alpha-3e_1^H+e_2^H+e_2^L\theta-\bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{\theta}-\theta\right)=\alpha+2e_1^H+e_2^H+2e_1^L\theta-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{10\phi(\alpha-\bar{c})\left(5\phi-2\theta^2\right)}{(125\phi^2-4\theta^2)(5\phi-\theta^2-1)} \\ e_2^H &= \frac{(\alpha-\bar{c})(5\phi-2\theta)(5\phi+2\theta)}{(125\phi^2-4\theta^2)(5\phi-\theta^2-1)} \\ e_1^L &= \frac{10\phi\theta(\alpha-\bar{c})(5\phi-2)}{(125\phi^2-4\theta^2)(5\phi-\theta^2-1)} \\ e_2^L &= \frac{\theta(\alpha-\bar{c})(5\phi-2\theta)(5\phi+2\theta)}{(125\phi^2-4\theta^2)(5\phi-\theta^2-1)} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{25\alpha\phi^2\theta^2+75\alpha\phi^2-20\alpha\phi\theta^2-4\alpha\theta^4-4\alpha\theta^2-625\bar{c}\phi^3+100\bar{c}\phi^2\theta^2+50\bar{c}\phi^2+40\bar{c}\phi\theta^2}{(125\phi^2-4\theta^2)(5\phi-\theta^2-1)} \\ c_2^H &= -\frac{75\alpha\phi^2\theta^2+75\alpha\phi^2-40\alpha\phi\theta^2-4\alpha\theta^4-4\alpha\theta^2-625\bar{c}\phi^3+50\bar{c}\phi^2\theta^2+50\bar{c}\phi^2+60\bar{c}\phi\theta^2}{(125\phi^2-4\theta^2)(5\phi-\theta^2-1)} \\ c_1^L &= -\frac{75\alpha\phi^2\theta^2+25\alpha\phi^2-20\alpha\phi\theta^2-4\alpha\theta^4-4\alpha\theta^2-625\bar{c}\phi^3+50\bar{c}\phi^2\theta^2+100\bar{c}\phi^2+40\bar{c}\phi\theta^2}{(125\phi^2-4\theta^2)(5\phi-\theta^2-1)} \\ c_2^L &= -\frac{75\alpha\phi^2\theta^2+75\alpha\phi^2-40\alpha\phi\theta^2-4\alpha\theta^4-4\alpha\theta^2-625\bar{c}\phi^3+50\bar{c}\phi^2\theta^2+50\bar{c}\phi^2+60\bar{c}\phi\theta^2}{(125\phi^2-4\theta^2)(5\phi-\theta^2-1)} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{25\phi^2(\alpha-\bar{c})\left(5\phi-2\theta^2\right)}{(125\phi^2-4\theta^2)(5\phi-\theta^2-1)} \\ q_2^H &= \frac{5\phi(\alpha-\bar{c})(5\phi-2\theta)(5\phi+2\theta)}{(125\phi^2-4\theta^2)(5\phi-\theta^2-1)} \\ q_1^L &= \frac{25\phi^2(\alpha-\bar{c})(5\phi-2)}{(125\phi^2-4\theta^2)(5\phi-\theta^2-1)} \\ q_2^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-2\theta)(5\phi+2\theta)}{(125\phi^2-4\theta^2)(5\phi-\theta^2-1)} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{25\phi^3(\alpha-\bar{c})^2\left(5\phi-2\theta^2\right)^2\cdot(25\phi-4)}{(125\phi^2-4\theta^2)^2(5\phi-\theta^2-1)^2} \\ \pi_2^H &= \frac{\phi(\alpha-\bar{c})^2(5\phi-2\theta)^2(5\phi+2\theta)^2\cdot(25\phi-1)}{(125\phi^2-4\theta^2)^2(5\phi-\theta^2-1)^2} \\ \pi_1^L &= \frac{25\phi^3(\alpha-\bar{c})^2(5\phi-2)^2\cdot\left(25\phi-4\theta^2\right)}{(125\phi^2-4\theta^2)^2(5\phi-\theta^2-1)^2} \\ \pi_2^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-2\theta)^2(5\phi+2\theta)^2\cdot\left(25\phi-\theta^2\right)}{(125\phi^2-4\theta^2)^2(5\phi-\theta^2-1)^2} \end{cases} \tag{77}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(50\phi^2-5\phi\theta^2-5\phi-4\theta^2\right)}{\left(125\phi^2-4\theta^2\right)\left(5\phi-\theta^2-1\right)}$$

Price:

$$\frac{125\alpha\phi^3-75\alpha\phi^2\theta^2-75\alpha\phi^2+20\alpha\phi\theta^2+4\alpha\theta^4+4\alpha\theta^2+500\bar{c}\phi^3-50\bar{c}\phi^2\theta^2-50\bar{c}\phi^2-40\bar{c}\phi\theta^2}{\left(125\phi^2-4\theta^2\right)\left(5\phi-\theta^2-1\right)}$$

Firm Surplus:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(62500\phi^5-15625\phi^4\theta^2-15625\phi^4+2500\phi^3\theta^4-6000\phi^3\theta^2+2500\phi^3-200\phi^2\theta^4-200\phi^2\theta^2+800\phi\theta^4-16\theta^6-16\theta^4\right)}{\left(125\phi^2-4\theta^2\right)^2\left(5\phi-\theta^2-1\right)^2}$$

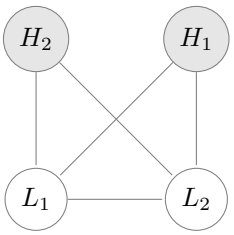
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(50\phi^2-5\phi\theta^2-5\phi-4\theta^2\right)^2}{\left(125\phi^2-4\theta^2\right)^2\left(5\phi-\theta^2-1\right)^2}$$

Social Welfare:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(187500\phi^5-40625\phi^4\theta^2-40625\phi^4+3750\phi^3\theta^4-23500\phi^3\theta^2+3750\phi^3+1800\phi^2\theta^4+1800\phi^2\theta^2+1600\phi\theta^4-16\theta^6-16\theta^4\right)}{\left(125\phi^2-4\theta^2\right)^2\left(5\phi-\theta^2-1\right)^2}$$

D.2.27 E5C [2H2L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{2}-2\right) = \alpha-3e_2^H+e_1^L\theta+e_2^L\theta-\bar{c} \\ e_2^H\cdot\left(\frac{25\phi}{2}-2\right) = \alpha-3e_1^H+e_1^L\theta+e_2^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{\theta}-\theta\right) = \alpha+2e_1^H+2e_2^H+e_2^L\theta-\bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{\theta}-\theta\right) = \alpha+2e_1^H+2e_2^H+e_1^L\theta-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{10\phi(\alpha-\bar{c})}{125\phi^2-10\phi\theta^2+10\phi-4\theta^2} \\ e_2^H &= \frac{10\phi(\alpha-\bar{c})}{125\phi^2-10\phi\theta^2+10\phi-4\theta^2} \\ e_1^L &= \frac{\theta(\alpha-\bar{c})(5\phi+2)}{125\phi^2-10\phi\theta^2+10\phi-4\theta^2} \\ e_2^L &= \frac{\theta(\alpha-\bar{c})(5\phi+2)}{125\phi^2-10\phi\theta^2+10\phi-4\theta^2} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{10\alpha\phi\theta^2+10\alpha\phi+4\alpha\theta^2-125\bar{c}\phi^2-20\bar{c}\phi}{125\phi^2-10\phi\theta^2+10\phi-4\theta^2} \\ c_2^H &= -\frac{10\alpha\phi\theta^2+10\alpha\phi+4\alpha\theta^2-125\bar{c}\phi^2-20\bar{c}\phi}{125\phi^2-10\phi\theta^2+10\phi-4\theta^2} \\ c_1^L &= -\frac{10\alpha\phi\theta^2+20\alpha\phi+4\alpha\theta^2-125\bar{c}\phi^2-30\bar{c}\phi}{125\phi^2-10\phi\theta^2+10\phi-4\theta^2} \\ c_2^L &= -\frac{10\alpha\phi\theta^2+20\alpha\phi+4\alpha\theta^2-125\bar{c}\phi^2-30\bar{c}\phi}{125\phi^2-10\phi\theta^2+10\phi-4\theta^2} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{25\phi^2(\alpha-\bar{c})}{125\phi^2-10\phi\theta^2+10\phi-4\theta^2} \\ q_2^H &= \frac{25\phi^2(\alpha-\bar{c})}{125\phi^2-10\phi\theta^2+10\phi-4\theta^2} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})(5\phi+2)}{125\phi^2-10\phi\theta^2+10\phi-4\theta^2} \\ q_2^L &= \frac{5\phi(\alpha-\bar{c})(5\phi+2)}{125\phi^2-10\phi\theta^2+10\phi-4\theta^2} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{25\phi^3(\alpha-\bar{c})^2\cdot(25\phi-4)}{(125\phi^2-10\phi\theta^2+10\phi-4\theta^2)^2} \\ \pi_2^H &= \frac{25\phi^3(\alpha-\bar{c})^2\cdot(25\phi-4)}{(125\phi^2-10\phi\theta^2+10\phi-4\theta^2)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi+2)^2\cdot\left(25\phi-\theta^2\right)}{(125\phi^2-10\phi\theta^2+10\phi-4\theta^2)^2} \\ \pi_2^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi+2)^2\cdot\left(25\phi-\theta^2\right)}{(125\phi^2-10\phi\theta^2+10\phi-4\theta^2)^2} \end{cases} \tag{78}$$

Total Production:

$$\frac{20\phi\left(\alpha-\bar{c}\right)\left(5\phi+1\right)}{125\phi^2-10\phi\theta^2+10\phi-4\theta^2}$$

Price:

$$\frac{25\alpha\phi^2-10\alpha\phi\theta^2-10\alpha\phi-4\alpha\theta^2+100\bar{c}\phi^2+20\bar{c}\phi}{125\phi^2-10\phi\theta^2+10\phi-4\theta^2}$$

Firm Surplus:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(1250\phi^3-25\phi^2\theta^2+400\phi^2-20\phi\theta^2+100\phi-4\theta^2\right)}{\left(125\phi^2-10\phi\theta^2+10\phi-4\theta^2\right)^2}$$

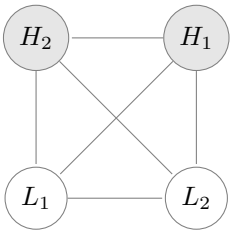
Consumer Surplus:

$$\frac{200\phi^2\left(\alpha-\bar{c}\right)^2\left(5\phi+1\right)^2}{\left(125\phi^2-10\phi\theta^2+10\phi-4\theta^2\right)^2}$$

Social Welfare:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(3750\phi^3-25\phi^2\theta^2+1400\phi^2-20\phi\theta^2+200\phi-4\theta^2\right)}{\left(125\phi^2-10\phi\theta^2+10\phi-4\theta^2\right)^2}$$

D.2.28 E6A [2H2L]



$$Equations: \begin{cases} e_1^H\cdot(25\phi-1) = \alpha + e_2^H + e_1^L\theta + e_2^L\theta - \bar{c} \\ e_2^H\cdot(25\phi-1) = \alpha + e_1^H + e_1^L\theta + e_2^L\theta - \bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{\theta}-\theta\right) = \alpha + e_1^H + e_2^H + e_2^L\theta - \bar{c} \\ e_2^L\cdot\left(\frac{25\phi}{\theta}-\theta\right) = \alpha + e_1^H + e_2^H + e_1^L\theta - \bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{\alpha-\bar{c}}{25\phi-2\theta^2-2} \\ e_2^H &= \frac{\alpha-\bar{c}}{25\phi-2\theta^2-2} \\ e_1^L &= \frac{\theta(\alpha-\bar{c})}{25\phi-2\theta^2-2} \\ e_2^L &= \frac{\theta(\alpha-\bar{c})}{25\phi-2\theta^2-2} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{2\alpha\theta^2+2\alpha-25\bar{c}\phi}{25\phi-2\theta^2-2} \\ c_2^H &= -\frac{2\alpha\theta^2+2\alpha-25\bar{c}\phi}{25\phi-2\theta^2-2} \\ c_1^L &= -\frac{2\alpha\theta^2+2\alpha-25\bar{c}\phi}{25\phi-2\theta^2-2} \\ c_2^L &= -\frac{2\alpha\theta^2+2\alpha-25\bar{c}\phi}{25\phi-2\theta^2-2} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})}{25\phi-2\theta^2-2} \\ q_2^H &= \frac{5\phi(\alpha-\bar{c})}{25\phi-2\theta^2-2} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})}{25\phi-2\theta^2-2} \\ q_2^L &= \frac{5\phi(\alpha-\bar{c})}{25\phi-2\theta^2-2} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\cdot(25\phi-1)}{(25\phi-2\theta^2-2)^2} \\ \pi_2^H &= \frac{\phi(\alpha-\bar{c})^2\cdot(25\phi-1)}{(25\phi-2\theta^2-2)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2\cdot\left(25\phi-\theta^2\right)}{(25\phi-2\theta^2-2)^2} \\ \pi_2^L &= \frac{\phi(\alpha-\bar{c})^2\cdot\left(25\phi-\theta^2\right)}{(25\phi-2\theta^2-2)^2} \end{cases} \tag{79}$$

Total Production:

$$\frac{20\phi\left(\alpha-\bar{c}\right)}{25\phi-2\theta^2-2}$$

Price:

$$\frac{5\alpha\phi-2\alpha\theta^2-2\alpha+20\bar{c}\phi}{25\phi-2\theta^2-2}$$

Firm Surplus:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(50\phi-\theta^2-1\right)}{\left(25\phi-2\theta^2-2\right)^2}$$

Consumer Surplus:

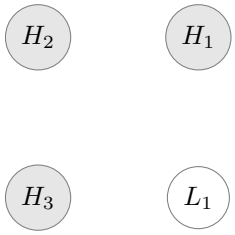
$$\frac{200\phi^2\left(\alpha-\bar{c}\right)^2}{\left(25\phi-2\theta^2-2\right)^2}$$

Social Welfare:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(150\phi-\theta^2-1\right)}{\left(25\phi-2\theta^2-2\right)^2}$$

D.3 Three *high*- and one *low*-productive firms ($3H1L$)

D.3.1 E0A [3H1L]



$$Equations: \begin{cases} e_1^H \cdot \left(\frac{25\phi}{4} - 4\right) = \alpha - e_2^H - e_3^H - e_1^L\theta - \bar{c} \\ e_2^H \cdot \left(\frac{25\phi}{4} - 4\right) = \alpha - e_1^H - e_3^H - e_1^L\theta - \bar{c} \\ e_3^H \cdot \left(\frac{25\phi}{4} - 4\right) = \alpha - e_1^H - e_2^H - e_1^L\theta - \bar{c} \\ e_1^L \cdot \left(\frac{25\phi}{4\theta} - 4\theta\right) = \alpha - e_1^H - e_2^H - e_3^H - \bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{4(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-80\phi\theta^2-40\phi+16\theta^2} \\ e_2^H &= \frac{4(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-80\phi\theta^2-40\phi+16\theta^2} \\ e_3^H &= \frac{4(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-80\phi\theta^2-40\phi+16\theta^2} \\ e_1^L &= \frac{4\theta(\alpha-\bar{c})(5\phi-4)}{125\phi^2-80\phi\theta^2-40\phi+16\theta^2} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{20\alpha\phi-16\alpha\theta^2-125\bar{c}\phi^2+80\bar{c}\phi\theta^2+20\bar{c}\phi}{125\phi^2-80\phi\theta^2-40\phi+16\theta^2} \\ c_2^H &= -\frac{20\alpha\phi-16\alpha\theta^2-125\bar{c}\phi^2+80\bar{c}\phi\theta^2+20\bar{c}\phi}{125\phi^2-80\phi\theta^2-40\phi+16\theta^2} \\ c_3^H &= -\frac{20\alpha\phi-16\alpha\theta^2-125\bar{c}\phi^2+80\bar{c}\phi\theta^2+20\bar{c}\phi}{125\phi^2-80\phi\theta^2-40\phi+16\theta^2} \\ c_1^L &= -\frac{20\alpha\phi\theta^2-16\alpha\theta^2-125\bar{c}\phi^2+60\bar{c}\phi\theta^2+40\bar{c}\phi}{125\phi^2-80\phi\theta^2-40\phi+16\theta^2} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-80\phi\theta^2-40\phi+16\theta^2} \\ q_2^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-80\phi\theta^2-40\phi+16\theta^2} \\ q_3^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-80\phi\theta^2-40\phi+16\theta^2} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-4)}{125\phi^2-80\phi\theta^2-40\phi+16\theta^2} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-4\theta^2\right)^2\cdot(25\phi-16)}{(125\phi^2-80\phi\theta^2-40\phi+16\theta^2)^2} \\ \pi_2^H &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-4\theta^2\right)^2\cdot(25\phi-16)}{(125\phi^2-80\phi\theta^2-40\phi+16\theta^2)^2} \\ \pi_3^H &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-4\theta^2\right)^2\cdot(25\phi-16)}{(125\phi^2-80\phi\theta^2-40\phi+16\theta^2)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-4)^2\cdot\left(25\phi-16\theta^2\right)}{(125\phi^2-80\phi\theta^2-40\phi+16\theta^2)^2} \end{cases} \tag{80}$$

Total Production:

$$\frac{20\phi\left(\alpha-\bar{c}\right)\left(5\phi-3\theta^2-1\right)}{125\phi^2-80\phi\theta^2-40\phi+16\theta^2}$$

Price:

$$\frac{25\alpha\phi^2-20\alpha\phi\theta^2-20\alpha\phi+16\alpha\theta^2+100\bar{c}\phi^2-60\bar{c}\phi\theta^2-20\bar{c}\phi}{125\phi^2-80\phi\theta^2-40\phi+16\theta^2}$$

Firm Surplus:

$$\frac{4\phi\left(\alpha-\bar{c}\right)^2\cdot\left(625\phi^3-850\phi^2\theta^2-550\phi^2+300\phi\theta^4+640\phi\theta^2+100\phi-192\theta^4-64\theta^2\right)}{\left(125\phi^2-80\phi\theta^2-40\phi+16\theta^2\right)^2}$$

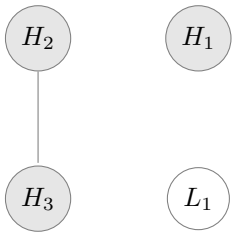
Consumer Surplus:

$$\frac{200\phi^2\left(\alpha-\bar{c}\right)^2\left(5\phi-3\theta^2-1\right)^2}{\left(125\phi^2-80\phi\theta^2-40\phi+16\theta^2\right)^2}$$

Social Welfare:

$$\frac{4\phi\left(\alpha-\bar{c}\right)^2\cdot\left(1875\phi^3-2350\phi^2\theta^2-1050\phi^2+750\phi\theta^4+940\phi\theta^2+150\phi-192\theta^4-64\theta^2\right)}{\left(125\phi^2-80\phi\theta^2-40\phi+16\theta^2\right)^2}$$

D.3.2 E1A [3H1L]



$$Equations:\begin{cases}e_1^H\cdot\left(\frac{25\phi}{4}-4\right)=\alpha-2e_2^H-2e_3^H-e_1^L\theta-\bar{c}\\ e_2^H\cdot\left(\frac{25\phi}{3}-3\right)=\alpha-e_1^H+3e_3^H-e_1^L\theta-\bar{c}\\ e_3^H\cdot\left(\frac{25\phi}{3}-3\right)=\alpha-e_1^H+3e_2^H-e_1^L\theta-\bar{c}\\ e_1^L\cdot\left(\frac{25\phi}{4\theta}-4\theta\right)=\alpha-e_1^H-2e_2^H-2e_3^H-\bar{c}\end{cases}$$

Optimal efforts:

$$\begin{cases}e_1^H &= \frac{4(\alpha-\bar{c})(5\phi-6)\left(5\phi-4\theta^2\right)}{625\phi^3-400\phi^2\theta^2-850\phi^2+480\phi\theta^2+240\phi-96\theta^2}\\ e_2^H &= \frac{3(\alpha-\bar{c})(5\phi-4)\left(5\phi-4\theta^2\right)}{625\phi^3-400\phi^2\theta^2-850\phi^2+480\phi\theta^2+240\phi-96\theta^2}\\ e_3^H &= \frac{3(\alpha-\bar{c})(5\phi-4)\left(5\phi-4\theta^2\right)}{625\phi^3-400\phi^2\theta^2-850\phi^2+480\phi\theta^2+240\phi-96\theta^2}\\ e_1^L &= \frac{4\theta(\alpha-\bar{c})(5\phi-6)(5\phi-4)}{625\phi^3-400\phi^2\theta^2-850\phi^2+480\phi\theta^2+240\phi-96\theta^2}\end{cases}$$

Production Costs:

$$\begin{cases}c_1^H &= -\frac{100\alpha\phi^2-80\alpha\phi\theta^2-120\alpha\phi+96\alpha\theta^2-625\bar{c}\phi^3+400\bar{c}\phi^2\theta^2+750\bar{c}\phi^2-400\bar{c}\phi\theta^2-120\bar{c}\phi}{625\phi^3-400\phi^2\theta^2-850\phi^2+480\phi\theta^2+240\phi-96\theta^2}\\ c_2^H &= -\frac{150\alpha\phi^2-120\alpha\phi\theta^2-120\alpha\phi+96\alpha\theta^2-625\bar{c}\phi^3+400\bar{c}\phi^2\theta^2+700\bar{c}\phi^2-360\bar{c}\phi\theta^2-120\bar{c}\phi}{625\phi^3-400\phi^2\theta^2-850\phi^2+480\phi\theta^2+240\phi-96\theta^2}\\ c_3^H &= -\frac{150\alpha\phi^2-120\alpha\phi\theta^2-120\alpha\phi+96\alpha\theta^2-625\bar{c}\phi^3+400\bar{c}\phi^2\theta^2+700\bar{c}\phi^2-360\bar{c}\phi\theta^2-120\bar{c}\phi}{625\phi^3-400\phi^2\theta^2-850\phi^2+480\phi\theta^2+240\phi-96\theta^2}\\ c_1^L &= -\frac{100\alpha\phi^2\theta^2-200\alpha\phi\theta^2+96\alpha\theta^2-625\bar{c}\phi^3+300\bar{c}\phi^2\theta^2+850\bar{c}\phi^2-280\bar{c}\phi\theta^2-240\bar{c}\phi}{625\phi^3-400\phi^2\theta^2-850\phi^2+480\phi\theta^2+240\phi-96\theta^2}\end{cases}$$

Production Quantities:

$$\begin{cases}q_1^H &= \frac{5\phi(\alpha-\bar{c})(5\phi-6)\left(5\phi-4\theta^2\right)}{625\phi^3-400\phi^2\theta^2-850\phi^2+480\phi\theta^2+240\phi-96\theta^2}\\ q_2^H &= \frac{5\phi(\alpha-\bar{c})(5\phi-4)\left(5\phi-4\theta^2\right)}{625\phi^3-400\phi^2\theta^2-850\phi^2+480\phi\theta^2+240\phi-96\theta^2}\\ q_3^H &= \frac{5\phi(\alpha-\bar{c})(5\phi-4)\left(5\phi-4\theta^2\right)}{625\phi^3-400\phi^2\theta^2-850\phi^2+480\phi\theta^2+240\phi-96\theta^2}\\ q_1^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-6)(5\phi-4)}{625\phi^3-400\phi^2\theta^2-850\phi^2+480\phi\theta^2+240\phi-96\theta^2}\end{cases}$$

Profits:

$$\begin{cases}\pi_1^H &= \frac{\phi(\alpha-\bar{c})^2(5\phi-6)^2\left(5\phi-4\theta^2\right)^2\cdot(25\phi-16)}{(625\phi^3-400\phi^2\theta^2-850\phi^2+480\phi\theta^2+240\phi-96\theta^2)^2}\\ \pi_2^H &= \frac{\phi(\alpha-\bar{c})^2(5\phi-4)^2\left(5\phi-4\theta^2\right)^2\cdot(25\phi-9)}{(625\phi^3-400\phi^2\theta^2-850\phi^2+480\phi\theta^2+240\phi-96\theta^2)^2}\\ \pi_3^H &= \frac{\phi(\alpha-\bar{c})^2(5\phi-4)^2\left(5\phi-4\theta^2\right)^2\cdot(25\phi-9)}{(625\phi^3-400\phi^2\theta^2-850\phi^2+480\phi\theta^2+240\phi-96\theta^2)^2}\\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-6)^2(5\phi-4)^2\cdot\left(25\phi-16\theta^2\right)}{(625\phi^3-400\phi^2\theta^2-850\phi^2+480\phi\theta^2+240\phi-96\theta^2)^2}\end{cases}\tag{81}$$

Total Production:

$$\frac{20\phi\left(\alpha-\bar{c}\right)\left(25\phi^2-15\phi\theta^2-30\phi+14\theta^2+6\right)}{625\phi^3-400\phi^2\theta^2-850\phi^2+480\phi\theta^2+240\phi-96\theta^2}$$

Price:

$$\frac{125\alpha\phi^3-100\alpha\phi^2\theta^2-250\alpha\phi^2+200\alpha\phi\theta^2+120\alpha\phi-96\alpha\theta^2+500\bar{c}\phi^3-300\bar{c}\phi^2\theta^2-600\bar{c}\phi^2+280\bar{c}\phi\theta^2+120\bar{c}\phi}{625\phi^3-400\phi^2\theta^2-850\phi^2+480\phi\theta^2+240\phi-96\theta^2}$$

Firm Surplus:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(31250\phi^5-42500\phi^4\theta^2-85625\phi^4+15000\phi^3\theta^4+107000\phi^3\theta^2+88500\phi^3-34800\phi^2\theta^4-97200\phi^2\theta^2-40800\phi^2+27040\phi\theta^4+36480\phi\theta^2+7200\phi-6912\theta^4-4608\theta^2\right)}{\left(625\phi^3-400\phi^2\theta^2-850\phi^2+480\phi\theta^2+240\phi-96\theta^2\right)^2}$$

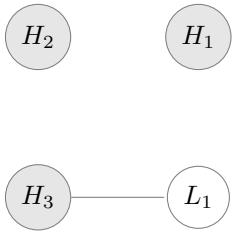
Consumer Surplus:

$$\frac{200\phi^2\left(\alpha-\bar{c}\right)^2\left(25\phi^2-15\phi\theta^2-30\phi+14\theta^2+6\right)^2}{\left(625\phi^3-400\phi^2\theta^2-850\phi^2+480\phi\theta^2+240\phi-96\theta^2\right)^2}$$

Social Welfare:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(93750\phi^5-117500\phi^4\theta^2-235625\phi^4+37500\phi^3\theta^4+267000\phi^3\theta^2+208500\phi^3-76800\phi^2\theta^4-199200\phi^2\theta^2-76800\phi^2+46640\phi\theta^4+53280\phi\theta^2+10800\phi-6912\theta^4-4608\theta^2\right)}{\left(625\phi^3-400\phi^2\theta^2-850\phi^2+480\phi\theta^2+240\phi-96\theta^2\right)^2}$$

D.3.3 E1B [3H1L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{4}-4\right)=\alpha-e_2^H-2e_3^H-2e_1^L\theta-\bar{c} \\ e_2^H\cdot\left(\frac{25\phi}{4}-4\right)=\alpha-e_1^H-2e_3^H-2e_1^L\theta-\bar{c} \\ e_3^H\cdot\left(\frac{25\phi}{3}-3\right)=\alpha-e_1^H-e_2^H+3e_1^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right)=\alpha-e_1^H-e_2^H+3e_3^H-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{4(\alpha-\bar{c})\left(5\phi-3\theta^2-3\right)}{125\phi^2-45\phi\theta^2-105\phi+12\theta^2+12} \\ e_2^H &= \frac{4(\alpha-\bar{c})\left(5\phi-3\theta^2-3\right)}{125\phi^2-45\phi\theta^2-105\phi+12\theta^2+12} \\ e_3^H &= \frac{3(\alpha-\bar{c})(5\phi-4)}{125\phi^2-45\phi\theta^2-105\phi+12\theta^2+12} \\ e_1^L &= \frac{3\theta(\alpha-\bar{c})(5\phi-4)}{125\phi^2-45\phi\theta^2-105\phi+12\theta^2+12} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{20\alpha\phi-12\alpha\theta^2-12\alpha-125\bar{c}\phi^2+45\bar{c}\phi\theta^2+85\bar{c}\phi}{125\phi^2-45\phi\theta^2-105\phi+12\theta^2+12} \\ c_2^H &= -\frac{20\alpha\phi-12\alpha\theta^2-12\alpha-125\bar{c}\phi^2+45\bar{c}\phi\theta^2+85\bar{c}\phi}{125\phi^2-45\phi\theta^2-105\phi+12\theta^2+12} \\ c_3^H &= -\frac{15\alpha\phi\theta^2+15\alpha\phi-12\alpha\theta^2-12\alpha-125\bar{c}\phi^2+30\bar{c}\phi\theta^2+90\bar{c}\phi}{125\phi^2-45\phi\theta^2-105\phi+12\theta^2+12} \\ c_1^L &= -\frac{15\alpha\phi\theta^2+15\alpha\phi-12\alpha\theta^2-12\alpha-125\bar{c}\phi^2+30\bar{c}\phi\theta^2+90\bar{c}\phi}{125\phi^2-45\phi\theta^2-105\phi+12\theta^2+12} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-3\theta^2-3\right)}{125\phi^2-45\phi\theta^2-105\phi+12\theta^2+12} \\ q_2^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-3\theta^2-3\right)}{125\phi^2-45\phi\theta^2-105\phi+12\theta^2+12} \\ q_3^H &= \frac{5\phi(\alpha-\bar{c})(5\phi-4)}{125\phi^2-45\phi\theta^2-105\phi+12\theta^2+12} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-4)}{125\phi^2-45\phi\theta^2-105\phi+12\theta^2+12} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\cdot(25\phi-16)\left(5\phi-3\theta^2-3\right)^2}{(125\phi^2-45\phi\theta^2-105\phi+12\theta^2+12)^2} \\ \pi_2^H &= \frac{\phi(\alpha-\bar{c})^2\cdot(25\phi-16)\left(5\phi-3\theta^2-3\right)^2}{(125\phi^2-45\phi\theta^2-105\phi+12\theta^2+12)^2} \\ \pi_3^H &= \frac{\phi(\alpha-\bar{c})^2(5\phi-4)^2\cdot(25\phi-9)}{(125\phi^2-45\phi\theta^2-105\phi+12\theta^2+12)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-4)^2\cdot\left(25\phi-9\theta^2\right)}{(125\phi^2-45\phi\theta^2-105\phi+12\theta^2+12)^2} \end{cases} \tag{82}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(10\phi-3\theta^2-7\right)}{125\phi^2-45\phi\theta^2-105\phi+12\theta^2+12}$$

Price:

$$\frac{25\alpha\phi^2-15\alpha\phi\theta^2-35\alpha\phi+12\alpha\theta^2+12\alpha+100\bar{c}\phi^2-30\bar{c}\phi\theta^2-70\bar{c}\phi}{125\phi^2-45\phi\theta^2-105\phi+12\theta^2+12}$$

Firm Surplus:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(2500\phi^3-1725\phi^2\theta^2-4525\phi^2+450\phi\theta^4+2220\phi\theta^2+2570\phi-288\theta^4-720\theta^2-432\right)}{\left(125\phi^2-45\phi\theta^2-105\phi+12\theta^2+12\right)^2}$$

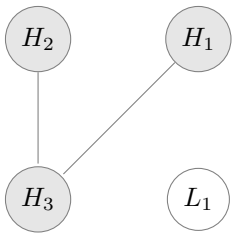
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(10\phi-3\theta^2-7\right)^2}{\left(125\phi^2-45\phi\theta^2-105\phi+12\theta^2+12\right)^2}$$

Social Welfare:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(7500\phi^3-4725\phi^2\theta^2-11525\phi^2+900\phi\theta^4+4320\phi\theta^2+5020\phi-288\theta^4-720\theta^2-432\right)}{\left(125\phi^2-45\phi\theta^2-105\phi+12\theta^2+12\right)^2}$$

D.3.4 E2A [3H1L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{3}-3\right)=\alpha-2e_2^H+2e_3^H-e_1^L\theta-\bar{c} \\ e_2^H\cdot\left(\frac{25\phi}{3}-3\right)=\alpha-2e_1^H+2e_3^H-e_1^L\theta-\bar{c} \\ e_3^H\cdot\left(\frac{25\phi}{2}-2\right)=\alpha+3e_1^H+3e_2^H-e_1^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{4\theta}-4\theta\right)=\alpha-2e_1^H-2e_2^H-3e_3^H-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{15\phi(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{(5\phi+1)(125\phi^2-80\phi\theta^2-60\phi+24\theta^2)} \\ e_2^H &= \frac{15\phi(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{(5\phi+1)(125\phi^2-80\phi\theta^2-60\phi+24\theta^2)} \\ e_3^H &= \frac{2(\alpha-\bar{c})(5\phi+3)\left(5\phi-4\theta^2\right)}{(5\phi+1)(125\phi^2-80\phi\theta^2-60\phi+24\theta^2)} \\ e_1^L &= \frac{4\theta(\alpha-\bar{c})(5\phi-6)}{125\phi^2-80\phi\theta^2-60\phi+24\theta^2} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{125\alpha\phi^2-100\alpha\phi\theta^2+30\alpha\phi-24\alpha\theta^2-625\bar{c}\phi^3+400\bar{c}\phi^2\theta^2+50\bar{c}\phi^2+60\bar{c}\phi\theta^2+30\bar{c}\phi}{(5\phi+1)(125\phi^2-80\phi\theta^2-60\phi+24\theta^2)} \\ c_2^H &= -\frac{125\alpha\phi^2-100\alpha\phi\theta^2+30\alpha\phi-24\alpha\theta^2-625\bar{c}\phi^3+400\bar{c}\phi^2\theta^2+50\bar{c}\phi^2+60\bar{c}\phi\theta^2+30\bar{c}\phi}{(5\phi+1)(125\phi^2-80\phi\theta^2-60\phi+24\theta^2)} \\ c_3^H &= -\frac{200\alpha\phi^2-160\alpha\phi\theta^2+30\alpha\phi-24\alpha\theta^2-625\bar{c}\phi^3+400\bar{c}\phi^2\theta^2-25\bar{c}\phi^2+120\bar{c}\phi\theta^2+30\bar{c}\phi}{(5\phi+1)(125\phi^2-80\phi\theta^2-60\phi+24\theta^2)} \\ c_1^L &= -\frac{20\alpha\phi\theta^2-24\alpha\theta^2-125\bar{c}\phi^2+60\bar{c}\phi\theta^2+60\bar{c}\phi}{125\phi^2-80\phi\theta^2-60\phi+24\theta^2} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{25\phi^2(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{(5\phi+1)(125\phi^2-80\phi\theta^2-60\phi+24\theta^2)} \\ q_2^H &= \frac{25\phi^2(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{(5\phi+1)(125\phi^2-80\phi\theta^2-60\phi+24\theta^2)} \\ q_3^H &= \frac{5\phi(\alpha-\bar{c})(5\phi+3)\left(5\phi-4\theta^2\right)}{(5\phi+1)(125\phi^2-80\phi\theta^2-60\phi+24\theta^2)} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-6)}{125\phi^2-80\phi\theta^2-60\phi+24\theta^2} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{25\phi^3(\alpha-\bar{c})^2\left(5\phi-4\theta^2\right)^2\cdot(25\phi-9)}{(5\phi+1)^2(125\phi^2-80\phi\theta^2-60\phi+24\theta^2)^2} \\ \pi_2^H &= \frac{25\phi^3(\alpha-\bar{c})^2\left(5\phi-4\theta^2\right)^2\cdot(25\phi-9)}{(5\phi+1)^2(125\phi^2-80\phi\theta^2-60\phi+24\theta^2)^2} \\ \pi_3^H &= \frac{\phi(\alpha-\bar{c})^2(5\phi+3)^2\left(5\phi-4\theta^2\right)^2\cdot(25\phi-4)}{(5\phi+1)^2(125\phi^2-80\phi\theta^2-60\phi+24\theta^2)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-6)^2\cdot\left(25\phi-16\theta^2\right)}{(125\phi^2-80\phi\theta^2-60\phi+24\theta^2)^2} \end{cases} \tag{83}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(10\phi-6\theta^2-3\right)}{125\phi^2-80\phi\theta^2-60\phi+24\theta^2}$$

Price:

$$\frac{25\alpha\phi^2-20\alpha\phi\theta^2-30\alpha\phi+24\alpha\theta^2+100\bar{c}\phi^2-60\bar{c}\phi\theta^2-30\bar{c}\phi}{125\phi^2-80\phi\theta^2-60\phi+24\theta^2}$$

Firm Surplus:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(31250\phi^5-42500\phi^4\theta^2-13125\phi^4+15000\phi^3\theta^4+6000\phi^3\theta^2+5375\phi^3+1600\phi^2\theta^4-4700\phi^2\theta^2+3300\phi^2+840\phi\theta^4-1680\phi\theta^2+450\phi-288\theta^4-288\theta^2\right)}{\left(5\phi+1\right)^2\left(125\phi^2-80\phi\theta^2-60\phi+24\theta^2\right)^2}$$

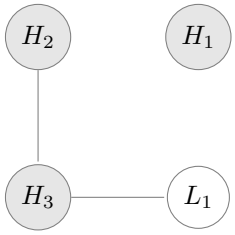
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(10\phi-6\theta^2-3\right)^2}{\left(125\phi^2-80\phi\theta^2-60\phi+24\theta^2\right)^2}$$

Social Welfare:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(93750\phi^5-117500\phi^4\theta^2-25625\phi^4+37500\phi^3\theta^4-1500\phi^3\theta^2-1500\phi^3+10600\phi^2\theta^4+1300\phi^2\theta^2+4050\phi^2+1740\phi\theta^4-780\phi\theta^2+675\phi-288\theta^4-288\theta^2\right)}{\left(5\phi+1\right)^2\left(125\phi^2-80\phi\theta^2-60\phi+24\theta^2\right)^2}$$

D.3.5 E2B [3H1L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{4}-4\right)=\alpha-2e_2^H-3e_3^H-2e_1^L\theta-\bar{c} \\ e_2^H\cdot\left(\frac{25\phi}{3}-3\right)=\alpha-e_1^H+2e_3^H-2e_1^L\theta-\bar{c} \\ e_3^H\cdot\left(\frac{25\phi}{2}-2\right)=\alpha-e_1^H+3e_2^H+3e_1^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right)=\alpha-e_1^H-2e_2^H+2e_3^H-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{4(\alpha-\bar{c})\left(125\phi^3-75\phi^2\theta^2-125\phi^2+45\phi\theta^2+18\theta^2\right)}{3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2} \\ e_2^H &= \frac{15\phi(\alpha-\bar{c})(5\phi-4)\left(5\phi-3\theta^2\right)}{3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2} \\ e_3^H &= \frac{2(\alpha-\bar{c})(5\phi-4)(5\phi-3\theta)(5\phi+3\theta)}{3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2} \\ e_1^L &= \frac{15\phi\theta(\alpha-\bar{c})(5\phi-4)(5\phi-3)}{3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{500\alpha\phi^3-300\alpha\phi^2\theta^2-500\alpha\phi^2+180\alpha\phi\theta^2+72\alpha\theta^2-3125\bar{c}\phi^4+1125\bar{c}\phi^3\theta^2+3125\bar{c}\phi^3-525\bar{c}\phi^2\theta^2-300\bar{c}\phi^2-360\bar{c}\phi\theta^2}{3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2} \\ c_2^H &= -\frac{625\alpha\phi^3-225\alpha\phi^2\theta^2-500\alpha\phi^2+90\alpha\phi\theta^2+72\alpha\theta^2-3125\bar{c}\phi^4+1125\bar{c}\phi^3\theta^2+3000\bar{c}\phi^3-600\bar{c}\phi^2\theta^2-300\bar{c}\phi^2-270\bar{c}\phi\theta^2}{3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2} \\ c_3^H &= -\frac{375\alpha\phi^3\theta^2+625\alpha\phi^3-750\alpha\phi^2\theta^2-500\alpha\phi^2+270\alpha\phi\theta^2+72\alpha\theta^2-3125\bar{c}\phi^4+750\bar{c}\phi^3\theta^2+3000\bar{c}\phi^3-75\bar{c}\phi^2\theta^2-300\bar{c}\phi^2-450\bar{c}\phi\theta^2}{3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2} \\ c_1^L &= -\frac{375\alpha\phi^3\theta^2+250\alpha\phi^3-525\alpha\phi^2\theta^2-200\alpha\phi^2+90\alpha\phi\theta^2+72\alpha\theta^2-3125\bar{c}\phi^4+750\bar{c}\phi^3\theta^2+3375\bar{c}\phi^3-300\bar{c}\phi^2\theta^2-600\bar{c}\phi^2-270\bar{c}\phi\theta^2}{3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})\left(125\phi^3-75\phi^2\theta^2-125\phi^2+45\phi\theta^2+18\theta^2\right)}{3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2} \\ q_2^H &= \frac{25\phi^2(\alpha-\bar{c})(5\phi-4)\left(5\phi-3\theta^2\right)}{3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2} \\ q_3^H &= \frac{5\phi(\alpha-\bar{c})(5\phi-4)(5\phi-3\theta)(5\phi+3\theta)}{3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2} \\ q_1^L &= \frac{25\phi^2(\alpha-\bar{c})(5\phi-4)(5\phi-3)}{3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\cdot(25\phi-16)\left(125\phi^3-75\phi^2\theta^2-125\phi^2+45\phi\theta^2+18\theta^2\right)^2}{(3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2)^2} \\ \pi_2^H &= \frac{25\phi^3(\alpha-\bar{c})^2(5\phi-4)^2\left(5\phi-3\theta^2\right)^2\cdot(25\phi-9)}{(3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2)^2} \\ \pi_3^H &= \frac{\phi(\alpha-\bar{c})^2(5\phi-4)^2(5\phi-3\theta)^2(5\phi+3\theta)^2\cdot(25\phi-4)}{(3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2)^2} \\ \pi_1^L &= \frac{25\phi^3(\alpha-\bar{c})^2(5\phi-4)^2(5\phi-3)^2\cdot\left(25\phi-9\theta^2\right)}{(3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2)^2} \end{cases} \tag{84}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(250\phi^3-75\phi^2\theta^2-250\phi^2+30\phi\theta^2+30\phi+27\theta^2\right)}{3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2}$$

Price:

$$\frac{625\alpha\phi^4-375\alpha\phi^3\theta^2-1125\alpha\phi^3+525\alpha\phi^2\theta^2+500\alpha\phi^2-90\alpha\phi\theta^2-72\alpha\theta^2+2500\bar{c}\phi^4-750\bar{c}\phi^3\theta^2-2500\bar{c}\phi^3+300\bar{c}\phi^2\theta^2+300\bar{c}\phi^2+270\bar{c}\phi\theta^2}{3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2}$$

Firm Surplus:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(1562500\phi^7-1078125\phi^6\theta^2-3578125\phi^6+281250\phi^5\theta^4+2081250\phi^5\theta^2+2856250\phi^5-534375\phi^4\theta^4-1134375\phi^4\theta^2-905000\phi^4+312750\phi^3\theta^4+40500\phi^3\theta^2+90000\phi^3-70200\phi^2\theta^4+68400\phi^2\theta^2+27540\phi\theta^4-10368\theta^4\right)}{\left(3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2\right)^2}$$

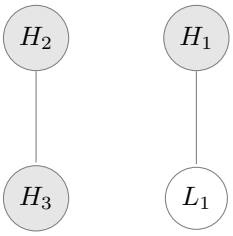
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(250\phi^3-75\phi^2\theta^2-250\phi^2+30\phi\theta^2+30\phi+27\theta^2\right)^2}{\left(3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2\right)^2}$$

Social Welfare:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(4687500\phi^7-2953125\phi^6\theta^2-9828125\phi^6+562500\phi^5\theta^4+4706250\phi^5\theta^2+6731250\phi^5-759375\phi^4\theta^4-1434375\phi^4\theta^2-1655000\phi^4+155250\phi^3\theta^4-544500\phi^3\theta^2+135000\phi^3+10800\phi^2\theta^4+149400\phi^2\theta^2+63990\phi\theta^4-10368\theta^4\right)}{\left(3125\phi^4-1125\phi^3\theta^2-3625\phi^3+825\phi^2\theta^2+800\phi^2+180\phi\theta^2-72\theta^2\right)^2}$$

D.3.6 E2C [3H1L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{3}-3\right)=\alpha-2e_2^H-2e_3^H+3e_1^L\theta-\bar{c} \\ e_2^H\cdot\left(\frac{25\phi}{3}-3\right)=\alpha-2e_1^H+3e_3^H-2e_1^L\theta-\bar{c} \\ e_3^H\cdot\left(\frac{25\phi}{3}-3\right)=\alpha-2e_1^H+3e_2^H-2e_1^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right)=\alpha+3e_1^H-2e_2^H-2e_3^H-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{3(\alpha-\bar{c})(5\phi-6)}{125\phi^2-45\phi\theta^2-135\phi+18\theta^2+18} \\ e_2^H &= \frac{3(\alpha-\bar{c})\left(5\phi-3\theta^2-3\right)}{125\phi^2-45\phi\theta^2-135\phi+18\theta^2+18} \\ e_3^H &= \frac{3(\alpha-\bar{c})\left(5\phi-3\theta^2-3\right)}{125\phi^2-45\phi\theta^2-135\phi+18\theta^2+18} \\ e_1^L &= \frac{3\theta(\alpha-\bar{c})(5\phi-6)}{125\phi^2-45\phi\theta^2-135\phi+18\theta^2+18} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{15\alpha\phi\theta^2+15\alpha\phi-18\alpha\theta^2-18\alpha-125\bar{c}\phi^2+30\bar{c}\phi\theta^2+120\bar{c}\phi}{125\phi^2-45\phi\theta^2-135\phi+18\theta^2+18} \\ c_2^H &= -\frac{30\alpha\phi-18\alpha\theta^2-18\alpha-125\bar{c}\phi^2+45\bar{c}\phi\theta^2+105\bar{c}\phi}{125\phi^2-45\phi\theta^2-135\phi+18\theta^2+18} \\ c_3^H &= -\frac{30\alpha\phi-18\alpha\theta^2-18\alpha-125\bar{c}\phi^2+45\bar{c}\phi\theta^2+105\bar{c}\phi}{125\phi^2-45\phi\theta^2-135\phi+18\theta^2+18} \\ c_1^L &= -\frac{15\alpha\phi\theta^2+15\alpha\phi-18\alpha\theta^2-18\alpha-125\bar{c}\phi^2+30\bar{c}\phi\theta^2+120\bar{c}\phi}{125\phi^2-45\phi\theta^2-135\phi+18\theta^2+18} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})(5\phi-6)}{125\phi^2-45\phi\theta^2-135\phi+18\theta^2+18} \\ q_2^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-3\theta^2-3\right)}{125\phi^2-45\phi\theta^2-135\phi+18\theta^2+18} \\ q_3^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-3\theta^2-3\right)}{125\phi^2-45\phi\theta^2-135\phi+18\theta^2+18} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-6)}{125\phi^2-45\phi\theta^2-135\phi+18\theta^2+18} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2(5\phi-6)^2\cdot(25\phi-9)}{(125\phi^2-45\phi\theta^2-135\phi+18\theta^2+18)^2} \\ \pi_2^H &= \frac{\phi(\alpha-\bar{c})^2\cdot(25\phi-9)\left(5\phi-3\theta^2-3\right)^2}{(125\phi^2-45\phi\theta^2-135\phi+18\theta^2+18)^2} \\ \pi_3^H &= \frac{\phi(\alpha-\bar{c})^2\cdot(25\phi-9)\left(5\phi-3\theta^2-3\right)^2}{(125\phi^2-45\phi\theta^2-135\phi+18\theta^2+18)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-6)^2\cdot\left(25\phi-9\theta^2\right)}{(125\phi^2-45\phi\theta^2-135\phi+18\theta^2+18)^2} \end{cases} \tag{85}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(10\phi-3\theta^2-9\right)}{125\phi^2-45\phi\theta^2-135\phi+18\theta^2+18}$$

Price:

$$\frac{25\alpha\phi^2-15\alpha\phi\theta^2-45\alpha\phi+18\alpha\theta^2+18\alpha+100\bar{c}\phi^2-30\bar{c}\phi\theta^2-90\bar{c}\phi}{125\phi^2-45\phi\theta^2-135\phi+18\theta^2+18}$$

Firm Surplus:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(2500\phi^3-1725\phi^2\theta^2-5175\phi^2+450\phi\theta^4+1980\phi\theta^2+3330\phi-162\theta^4-648\theta^2-486\right)}{\left(125\phi^2-45\phi\theta^2-135\phi+18\theta^2+18\right)^2}$$

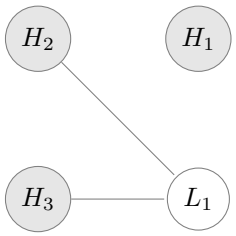
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(10\phi-3\theta^2-9\right)^2}{\left(125\phi^2-45\phi\theta^2-135\phi+18\theta^2+18\right)^2}$$

Social Welfare:

$$\frac{3\phi\left(\alpha-\bar{c}\right)^2\cdot\left(2500\phi^3-1575\phi^2\theta^2-4725\phi^2+300\phi\theta^4+1560\phi\theta^2+2460\phi-54\theta^4-216\theta^2-162\right)}{\left(125\phi^2-45\phi\theta^2-135\phi+18\theta^2+18\right)^2}$$

D.3.7 E2D [3H1L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{4}-4\right) = \alpha-2e_2^H-2e_3^H-3e_1^L\theta-\bar{c} \\ e_2^H\cdot\left(\frac{25\phi}{3}-3\right) = \alpha-e_1^H-2e_3^H+2e_1^L\theta-\bar{c} \\ e_3^H\cdot\left(\frac{25\phi}{3}-3\right) = \alpha-e_1^H-2e_2^H+2e_1^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right) = \alpha-e_1^H+3e_2^H+3e_3^H-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{4(\alpha-\bar{c})\left(25\phi^2-10\phi\theta^2-15\phi-6\theta^2\right)}{625\phi^3-100\phi^2\theta^2-475\phi^2-20\phi\theta^2+24\theta^2} \\ e_2^H &= \frac{15\phi(\alpha-\bar{c})(5\phi-4)}{625\phi^3-100\phi^2\theta^2-475\phi^2-20\phi\theta^2+24\theta^2} \\ e_3^H &= \frac{15\phi(\alpha-\bar{c})(5\phi-4)}{625\phi^3-100\phi^2\theta^2-475\phi^2-20\phi\theta^2+24\theta^2} \\ e_1^L &= \frac{2\theta(\alpha-\bar{c})(5\phi-4)(5\phi+3)}{625\phi^3-100\phi^2\theta^2-475\phi^2-20\phi\theta^2+24\theta^2} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{100\alpha\phi^2-40\alpha\phi\theta^2-60\alpha\phi-24\alpha\theta^2-625\bar{c}\phi^3+100\bar{c}\phi^2\theta^2+375\bar{c}\phi^2+60\bar{c}\phi\theta^2+60\bar{c}\phi}{625\phi^3-100\phi^2\theta^2-475\phi^2-20\phi\theta^2+24\theta^2} \\ c_2^H &= -\frac{50\alpha\phi^2\theta^2+75\alpha\phi^2-10\alpha\phi\theta^2-60\alpha\phi-24\alpha\theta^2-625\bar{c}\phi^3+50\bar{c}\phi^2\theta^2+400\bar{c}\phi^2+30\bar{c}\phi\theta^2+60\bar{c}\phi}{625\phi^3-100\phi^2\theta^2-475\phi^2-20\phi\theta^2+24\theta^2} \\ c_3^H &= -\frac{50\alpha\phi^2\theta^2+75\alpha\phi^2-10\alpha\phi\theta^2-60\alpha\phi-24\alpha\theta^2-625\bar{c}\phi^3+50\bar{c}\phi^2\theta^2+400\bar{c}\phi^2+30\bar{c}\phi\theta^2+60\bar{c}\phi}{625\phi^3-100\phi^2\theta^2-475\phi^2-20\phi\theta^2+24\theta^2} \\ c_1^L &= -\frac{50\alpha\phi^2\theta^2+150\alpha\phi^2-10\alpha\phi\theta^2-120\alpha\phi-24\alpha\theta^2-625\bar{c}\phi^3+50\bar{c}\phi^2\theta^2+325\bar{c}\phi^2+30\bar{c}\phi\theta^2+120\bar{c}\phi}{625\phi^3-100\phi^2\theta^2-475\phi^2-20\phi\theta^2+24\theta^2} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})\left(25\phi^2-10\phi\theta^2-15\phi-6\theta^2\right)}{625\phi^3-100\phi^2\theta^2-475\phi^2-20\phi\theta^2+24\theta^2} \\ q_2^H &= \frac{25\phi^2(\alpha-\bar{c})(5\phi-4)}{625\phi^3-100\phi^2\theta^2-475\phi^2-20\phi\theta^2+24\theta^2} \\ q_3^H &= \frac{25\phi^2(\alpha-\bar{c})(5\phi-4)}{625\phi^3-100\phi^2\theta^2-475\phi^2-20\phi\theta^2+24\theta^2} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-4)(5\phi+3)}{625\phi^3-100\phi^2\theta^2-475\phi^2-20\phi\theta^2+24\theta^2} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\cdot(25\phi-16)\left(25\phi^2-10\phi\theta^2-15\phi-6\theta^2\right)^2}{(625\phi^3-100\phi^2\theta^2-475\phi^2-20\phi\theta^2+24\theta^2)^2} \\ \pi_2^H &= \frac{25\phi^3(\alpha-\bar{c})^2(5\phi-4)^2\cdot(25\phi-9)}{(625\phi^3-100\phi^2\theta^2-475\phi^2-20\phi\theta^2+24\theta^2)^2} \\ \pi_3^H &= \frac{25\phi^3(\alpha-\bar{c})^2(5\phi-4)^2\cdot(25\phi-9)}{(625\phi^3-100\phi^2\theta^2-475\phi^2-20\phi\theta^2+24\theta^2)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-4)^2(5\phi+3)^2\cdot\left(25\phi-4\theta^2\right)}{(625\phi^3-100\phi^2\theta^2-475\phi^2-20\phi\theta^2+24\theta^2)^2} \end{cases} \tag{86}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(50\phi^2-5\phi\theta^2-30\phi-3\theta^2-6\right)}{625\phi^3-100\phi^2\theta^2-475\phi^2-20\phi\theta^2+24\theta^2}$$

Price:

$$\frac{125\alpha\phi^3-50\alpha\phi^2\theta^2-175\alpha\phi^2+10\alpha\phi\theta^2+60\alpha\phi+24\alpha\theta^2+500\bar{c}\phi^3-50\bar{c}\phi^2\theta^2-300\bar{c}\phi^2-30\bar{c}\phi\theta^2-60\bar{c}\phi}{625\phi^3-100\phi^2\theta^2-475\phi^2-20\phi\theta^2+24\theta^2}$$

Firm Surplus:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(31250\phi^5-7500\phi^4\theta^2-48125\phi^4+1250\phi^3\theta^4+4500\phi^3\theta^2+20625\phi^3+700\phi^2\theta^4+3400\phi^2\theta^2-3900\phi^2-510\phi\theta^4-1680\phi\theta^2+1800\phi-288\theta^4-288\theta^2\right)}{\left(625\phi^3-100\phi^2\theta^2-475\phi^2-20\phi\theta^2+24\theta^2\right)^2}$$

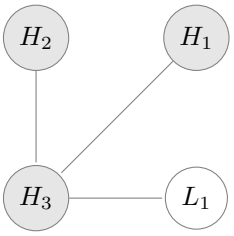
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(50\phi^2-5\phi\theta^2-30\phi-3\theta^2-6\right)^2}{\left(625\phi^3-100\phi^2\theta^2-475\phi^2-20\phi\theta^2+24\theta^2\right)^2}$$

Social Welfare:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(93750\phi^5-20000\phi^4\theta^2-123125\phi^4+1875\phi^3\theta^4+4500\phi^3\theta^2+28125\phi^3+1450\phi^2\theta^4+9400\phi^2\theta^2+5100\phi^2-285\phi\theta^4-780\phi\theta^2+2700\phi-288\theta^4-288\theta^2\right)}{\left(625\phi^3-100\phi^2\theta^2-475\phi^2-20\phi\theta^2+24\theta^2\right)^2}$$

D.3.8 E3A [3H1L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{3}-3\right) = \alpha-2e_2^H+e_3^H-2e_1^L\theta-\bar{c} \\ e_2^H\cdot\left(\frac{25\phi}{3}-3\right) = \alpha-2e_1^H+e_3^H-2e_1^L\theta-\bar{c} \\ e_3^H\cdot(25\phi-1) = \alpha+3e_1^H+3e_2^H+3e_1^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right) = \alpha-2e_1^H-2e_2^H+e_3^H-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{15\phi(\alpha-\bar{c})\left(5\phi-3\theta^2\right)}{625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2} \\ e_2^H &= \frac{15\phi(\alpha-\bar{c})\left(5\phi-3\theta^2\right)}{625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2} \\ e_3^H &= \frac{(\alpha-\bar{c})\left(25\phi^2+15\phi-18\theta^2\right)}{625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2} \\ e_1^L &= \frac{15\phi\theta(\alpha-\bar{c})(5\phi-3)}{625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{100\alpha\phi^2-45\alpha\phi\theta^2+15\alpha\phi-18\alpha\theta^2-625\bar{c}\phi^3+225\bar{c}\phi^2\theta^2+90\bar{c}\phi\theta^2}{625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2} \\ c_2^H &= -\frac{100\alpha\phi^2-45\alpha\phi\theta^2+15\alpha\phi-18\alpha\theta^2-625\bar{c}\phi^3+225\bar{c}\phi^2\theta^2+90\bar{c}\phi\theta^2}{625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2} \\ c_3^H &= -\frac{75\alpha\phi^2\theta^2+175\alpha\phi^2-135\alpha\phi\theta^2+15\alpha\phi-18\alpha\theta^2-625\bar{c}\phi^3+150\bar{c}\phi^2\theta^2-75\bar{c}\phi^2+180\bar{c}\phi\theta^2}{625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2} \\ c_1^L &= -\frac{75\alpha\phi^2\theta^2+25\alpha\phi^2-45\alpha\phi\theta^2+15\alpha\phi-18\alpha\theta^2-625\bar{c}\phi^3+150\bar{c}\phi^2\theta^2+75\bar{c}\phi^2+90\bar{c}\phi\theta^2}{625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{25\phi^2(\alpha-\bar{c})\left(5\phi-3\theta^2\right)}{625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2} \\ q_2^H &= \frac{25\phi^2(\alpha-\bar{c})\left(5\phi-3\theta^2\right)}{625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2} \\ q_3^H &= \frac{5\phi(\alpha-\bar{c})\left(25\phi^2+15\phi-18\theta^2\right)}{625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2} \\ q_1^L &= \frac{25\phi^2(\alpha-\bar{c})(5\phi-3)}{625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{25\phi^3(\alpha-\bar{c})^2\left(5\phi-3\theta^2\right)^2\cdot(25\phi-9)}{(625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2)^2} \\ \pi_2^H &= \frac{25\phi^3(\alpha-\bar{c})^2\left(5\phi-3\theta^2\right)^2\cdot(25\phi-9)}{(625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2)^2} \\ \pi_3^H &= \frac{\phi(\alpha-\bar{c})^2\cdot(25\phi-1)\left(25\phi^2+15\phi-18\theta^2\right)^2}{(625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2)^2} \\ \pi_1^L &= \frac{25\phi^3(\alpha-\bar{c})^2(5\phi-3)^2\cdot\left(25\phi-9\theta^2\right)}{(625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2)^2} \end{cases} \tag{87}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(50\phi^2-15\phi\theta^2-9\theta^2\right)}{625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2}$$

Price:

$$\frac{125\alpha\phi^3-75\alpha\phi^2\theta^2-100\alpha\phi^2+45\alpha\phi\theta^2-15\alpha\phi+18\alpha\theta^2+500\bar{c}\phi^3-150\bar{c}\phi^2\theta^2-90\bar{c}\phi\theta^2}{625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2}$$

Firm Surplus:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(62500\phi^5-43125\phi^4\theta^2-11875\phi^4+11250\phi^3\theta^4-2250\phi^3\theta^2+10500\phi^3-4050\phi^2\theta^4-14625\phi^2\theta^2-225\phi^2+8100\phi\theta^4+540\phi\theta^2-324\theta^4\right)}{\left(625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2\right)^2}$$

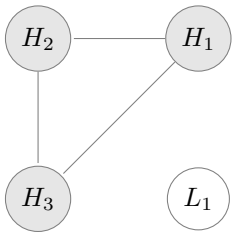
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(50\phi^2-15\phi\theta^2-9\theta^2\right)^2}{\left(625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2\right)^2}$$

Social Welfare:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(187500\phi^5-118125\phi^4\theta^2-11875\phi^4+22500\phi^3\theta^4-47250\phi^3\theta^2+10500\phi^3+9450\phi^2\theta^4-14625\phi^2\theta^2-225\phi^2+12150\phi\theta^4+540\phi\theta^2-324\theta^4\right)}{\left(625\phi^3-225\phi^2\theta^2-100\phi^2-45\phi\theta^2-15\phi+18\theta^2\right)^2}$$

D.3.9 E3B [3H1L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{2}-2\right)=\alpha+2e_2^H+2e_3^H-e_1^L\theta-\bar{c} \\ e_2^H\cdot\left(\frac{25\phi}{2}-2\right)=\alpha+2e_1^H+2e_3^H-e_1^L\theta-\bar{c} \\ e_3^H\cdot\left(\frac{25\phi}{2}-2\right)=\alpha+2e_1^H+2e_2^H-e_1^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{4\theta}-4\theta\right)=\alpha-3e_1^H-3e_2^H-3e_3^H-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{2(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-80\phi\theta^2-60\phi+24\theta^2} \\ e_2^H &= \frac{2(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-80\phi\theta^2-60\phi+24\theta^2} \\ e_3^H &= \frac{2(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-80\phi\theta^2-60\phi+24\theta^2} \\ e_1^L &= \frac{4\theta(\alpha-\bar{c})(5\phi-6)}{125\phi^2-80\phi\theta^2-60\phi+24\theta^2} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{30\alpha\phi-24\alpha\theta^2-125\bar{c}\phi^2+80\bar{c}\phi\theta^2+30\bar{c}\phi}{125\phi^2-80\phi\theta^2-60\phi+24\theta^2} \\ c_2^H &= -\frac{30\alpha\phi-24\alpha\theta^2-125\bar{c}\phi^2+80\bar{c}\phi\theta^2+30\bar{c}\phi}{125\phi^2-80\phi\theta^2-60\phi+24\theta^2} \\ c_3^H &= -\frac{30\alpha\phi-24\alpha\theta^2-125\bar{c}\phi^2+80\bar{c}\phi\theta^2+30\bar{c}\phi}{125\phi^2-80\phi\theta^2-60\phi+24\theta^2} \\ c_1^L &= -\frac{20\alpha\phi\theta^2-24\alpha\theta^2-125\bar{c}\phi^2+60\bar{c}\phi\theta^2+60\bar{c}\phi}{125\phi^2-80\phi\theta^2-60\phi+24\theta^2} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-80\phi\theta^2-60\phi+24\theta^2} \\ q_2^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-80\phi\theta^2-60\phi+24\theta^2} \\ q_3^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-4\theta^2\right)}{125\phi^2-80\phi\theta^2-60\phi+24\theta^2} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-6)}{125\phi^2-80\phi\theta^2-60\phi+24\theta^2} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-4\theta^2\right)^2\cdot(25\phi-4)}{(125\phi^2-80\phi\theta^2-60\phi+24\theta^2)^2} \\ \pi_2^H &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-4\theta^2\right)^2\cdot(25\phi-4)}{(125\phi^2-80\phi\theta^2-60\phi+24\theta^2)^2} \\ \pi_3^H &= \frac{\phi(\alpha-\bar{c})^2\left(5\phi-4\theta^2\right)^2\cdot(25\phi-4)}{(125\phi^2-80\phi\theta^2-60\phi+24\theta^2)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-6)^2\cdot\left(25\phi-16\theta^2\right)}{(125\phi^2-80\phi\theta^2-60\phi+24\theta^2)^2} \end{cases} \tag{88}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(10\phi-6\theta^2-3\right)}{125\phi^2-80\phi\theta^2-60\phi+24\theta^2}$$

Price:

$$\frac{25\alpha\phi^2-20\alpha\phi\theta^2-30\alpha\phi+24\alpha\theta^2+100\bar{c}\phi^2-60\bar{c}\phi\theta^2-30\bar{c}\phi}{125\phi^2-80\phi\theta^2-60\phi+24\theta^2}$$

Firm Surplus:

$$\frac{4\phi\left(\alpha-\bar{c}\right)^2\cdot\left(625\phi^3-850\phi^2\theta^2-450\phi^2+300\phi\theta^4+360\phi\theta^2+225\phi-48\theta^4-144\theta^2\right)}{\left(125\phi^2-80\phi\theta^2-60\phi+24\theta^2\right)^2}$$

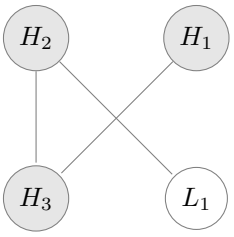
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(10\phi-6\theta^2-3\right)^2}{\left(125\phi^2-80\phi\theta^2-60\phi+24\theta^2\right)^2}$$

Social Welfare:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(3750\phi^3-4700\phi^2\theta^2-2400\phi^2+1500\phi\theta^4+1620\phi\theta^2+675\phi-96\theta^4-288\theta^2\right)}{\left(125\phi^2-80\phi\theta^2-60\phi+24\theta^2\right)^2}$$

D.3.10 E3C [3H1L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{3}-3\right)=\alpha-3e_2^H+2e_3^H-2e_1^L\theta-\bar{c} \\ e_2^H\cdot\left(\frac{25\phi}{2}-2\right)=\alpha-2e_1^H+2e_3^H+3e_1^L\theta-\bar{c} \\ e_3^H\cdot\left(\frac{25\phi}{2}-2\right)=\alpha+3e_1^H+2e_2^H-2e_1^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right)=\alpha-2e_1^H+2e_2^H-3e_3^H-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{3(\alpha-\bar{c})(5\phi-2)\left(25\phi^2-15\phi\theta^2-6\theta^2\right)}{3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2} \\ e_2^H &= \frac{10\phi(\alpha-\bar{c})\left(25\phi^2-15\phi-6\theta^2\right)}{3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2} \\ e_3^H &= \frac{10\phi(\alpha-\bar{c})\left(25\phi^2-15\phi\theta^2-6\right)}{3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2} \\ e_1^L &= \frac{3\theta(\alpha-\bar{c})(5\phi-2)\left(25\phi^2-15\phi-6\right)}{3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{625\alpha\phi^3-375\alpha\phi^2\theta^2-150\alpha\phi^2-60\alpha\phi+36\alpha\theta^2-3125\bar{c}\phi^4+1125\bar{c}\phi^3\theta^2+1500\bar{c}\phi^3+150\bar{c}\phi^2\theta^2+150\bar{c}\phi^2-120\bar{c}\phi\theta^2-60\bar{c}\phi}{3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2} \\ c_2^H &= -\frac{375\alpha\phi^3\theta^2+500\alpha\phi^3-525\alpha\phi^2\theta^2-150\alpha\phi^2-60\alpha\phi\theta^2-60\alpha\phi+36\alpha\theta^2-3125\bar{c}\phi^4+750\bar{c}\phi^3\theta^2+1625\bar{c}\phi^3+300\bar{c}\phi^2\theta^2+150\bar{c}\phi^2-60\bar{c}\phi\theta^2-60\bar{c}\phi}{3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2} \\ c_3^H &= -\frac{875\alpha\phi^3-375\alpha\phi^2\theta^2-300\alpha\phi^2-60\alpha\phi\theta^2-60\alpha\phi+36\alpha\theta^2-3125\bar{c}\phi^4+1125\bar{c}\phi^3\theta^2+1250\bar{c}\phi^3+150\bar{c}\phi^2\theta^2+300\bar{c}\phi^2-60\bar{c}\phi\theta^2-60\bar{c}\phi}{3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2} \\ c_1^L &= -\frac{375\alpha\phi^3\theta^2+250\alpha\phi^3-375\alpha\phi^2\theta^2-150\alpha\phi^2-60\alpha\phi\theta^2+36\alpha\theta^2-3125\bar{c}\phi^4+750\bar{c}\phi^3\theta^2+1875\bar{c}\phi^3+150\bar{c}\phi^2\theta^2+150\bar{c}\phi^2-60\bar{c}\phi\theta^2-120\bar{c}\phi}{3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})(5\phi-2)\left(25\phi^2-15\phi\theta^2-6\theta^2\right)}{3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2} \\ q_2^H &= \frac{25\phi^2(\alpha-\bar{c})\left(25\phi^2-15\phi-6\theta^2\right)}{3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2} \\ q_3^H &= \frac{25\phi^2(\alpha-\bar{c})\left(25\phi^2-15\phi\theta^2-6\right)}{3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-2)\left(25\phi^2-15\phi-6\right)}{3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2(5\phi-2)^2\cdot(25\phi-9)\left(25\phi^2-15\phi\theta^2-6\theta^2\right)^2}{(3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2)^2} \\ \pi_2^H &= \frac{25\phi^3(\alpha-\bar{c})^2\cdot(25\phi-4)\left(25\phi^2-15\phi-6\theta^2\right)^2}{(3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2)^2} \\ \pi_3^H &= \frac{25\phi^3(\alpha-\bar{c})^2\cdot(25\phi-4)\left(25\phi^2-15\phi\theta^2-6\right)^2}{(3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-2)^2\cdot\left(25\phi-9\theta^2\right)\left(25\phi^2-15\phi-6\right)^2}{(3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2)^2} \end{cases} \tag{89}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(5\phi-1\right)\left(50\phi^2-15\phi\theta^2-15\phi-6\theta^2-6\right)}{3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2}$$

Price:

$$\frac{625\alpha\phi^4-375\alpha\phi^3\theta^2-875\alpha\phi^3+375\alpha\phi^2\theta^2+150\alpha\phi^2+60\alpha\phi\theta^2+60\alpha\phi-36\alpha\theta^2+2500\bar{c}\phi^4-750\bar{c}\phi^3\theta^2-1250\bar{c}\phi^3-150\bar{c}\phi^2\theta^2-150\bar{c}\phi^2+60\bar{c}\phi\theta^2+60\bar{c}\phi}{3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2}$$

Firm Surplus:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(1562500\phi^7-1078125\phi^6\theta^2-1828125\phi^6+281250\phi^5\theta^4+525000\phi^5\theta^2+593750\phi^5-73125\phi^4\theta^4+121875\phi^4\theta^2+60000\phi^4-22500\phi^3\theta^4-120000\phi^3\theta^2-52500\phi^3+12600\phi^2\theta^4+37800\phi^2\theta^2-3600\phi^2+3600\phi\theta^4+3600\phi-1296\theta^4-1296\theta^2\right)}{\left(3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2\right)^2}$$

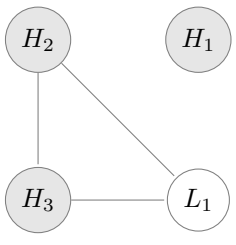
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(5\phi-1\right)^2\left(50\phi^2-15\phi\theta^2-15\phi-6\theta^2-6\right)^2}{\left(3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2\right)^2}$$

Social Welfare:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(4687500\phi^7-2953125\phi^6\theta^2-4953125\phi^6+562500\phi^5\theta^4+1087500\phi^5\theta^2+1000000\phi^5+39375\phi^4\theta^4+571875\phi^4\theta^2+397500\phi^4-56250\phi^3\theta^4-217500\phi^3\theta^2-116250\phi^3+3600\phi^2\theta^4+19800\phi^2\theta^2-12600\phi^2+5400\phi\theta^4+3600\phi\theta^2+5400\phi-1296\theta^4-1296\theta^2\right)}{\left(3125\phi^4-1125\phi^3\theta^2-2125\phi^3+225\phi^2\theta^2+120\phi\theta^2+120\phi-36\theta^2\right)^2}$$

D.3.11 E3D [3H1L]



$$Equations: \begin{cases} e_1^H \cdot \left(\frac{25\phi}{4} - 4\right) = \alpha - 3e_2^H - 3e_3^H - 3e_1^L\theta - \bar{c} \\ e_2^H \cdot \left(\frac{25\phi}{2} - 2\right) = \alpha - e_1^H + 2e_3^H + 2e_1^L\theta - \bar{c} \\ e_3^H \cdot \left(\frac{25\phi}{2} - 2\right) = \alpha - e_1^H + 2e_2^H + 2e_1^L\theta - \bar{c} \\ e_1^L \cdot \left(\frac{25\phi}{2\theta} - 2\theta\right) = \alpha - e_1^H + 2e_2^H + 2e_3^H - \bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{4(\alpha-\bar{c})\left(5\phi-2\theta^2-4\right)}{125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16} \\ e_2^H &= \frac{2(\alpha-\bar{c})(5\phi-4)}{125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16} \\ e_3^H &= \frac{2(\alpha-\bar{c})(5\phi-4)}{125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16} \\ e_1^L &= \frac{2\theta(\alpha-\bar{c})(5\phi-4)}{125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{20\alpha\phi-8\alpha\theta^2-16\alpha-125\bar{c}\phi^2+20\bar{c}\phi\theta^2+100\bar{c}\phi}{125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16} \\ c_2^H &= -\frac{10\alpha\phi\theta^2+20\alpha\phi-8\alpha\theta^2-16\alpha-125\bar{c}\phi^2+10\bar{c}\phi\theta^2+100\bar{c}\phi}{125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16} \\ c_3^H &= -\frac{10\alpha\phi\theta^2+20\alpha\phi-8\alpha\theta^2-16\alpha-125\bar{c}\phi^2+10\bar{c}\phi\theta^2+100\bar{c}\phi}{125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16} \\ c_1^L &= -\frac{10\alpha\phi\theta^2+20\alpha\phi-8\alpha\theta^2-16\alpha-125\bar{c}\phi^2+10\bar{c}\phi\theta^2+100\bar{c}\phi}{125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})\left(5\phi-2\theta^2-4\right)}{125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16} \\ q_2^H &= \frac{5\phi(\alpha-\bar{c})(5\phi-4)}{125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16} \\ q_3^H &= \frac{5\phi(\alpha-\bar{c})(5\phi-4)}{125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-4)}{125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\cdot(25\phi-16)\left(5\phi-2\theta^2-4\right)^2}{(125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16)^2} \\ \pi_2^H &= \frac{\phi(\alpha-\bar{c})^2(5\phi-4)^2\cdot(25\phi-4)}{(125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16)^2} \\ \pi_3^H &= \frac{\phi(\alpha-\bar{c})^2(5\phi-4)^2\cdot(25\phi-4)}{(125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-4)^2\cdot\left(25\phi-4\theta^2\right)}{(125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16)^2} \end{cases} \tag{90}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(10\phi-\theta^2-8\right)}{125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16}$$

Price:

$$\frac{25\alpha\phi^2-10\alpha\phi\theta^2-40\alpha\phi+8\alpha\theta^2+16\alpha+100\bar{c}\phi^2-10\bar{c}\phi\theta^2-80\bar{c}\phi}{125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16}$$

Firm Surplus:

$$\frac{4\phi\left(\alpha-\bar{c}\right)^2\cdot\left(625\phi^3-150\phi^2\theta^2-1150\phi^2+25\phi\theta^4+220\phi\theta^2+640\phi-16\theta^4-80\theta^2-96\right)}{\left(125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16\right)^2}$$

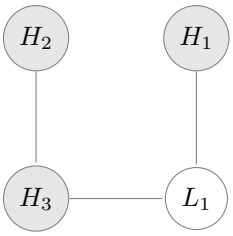
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(10\phi-\theta^2-8\right)^2}{\left(125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16\right)^2}$$

Social Welfare:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(3750\phi^3-800\phi^2\theta^2-6300\phi^2+75\phi\theta^4+840\phi\theta^2+2880\phi-32\theta^4-160\theta^2-192\right)}{\left(125\phi^2-20\phi\theta^2-120\phi+8\theta^2+16\right)^2}$$

D.3.12 E3E [3H1L]



$$Equations: \begin{cases} e_1^H \cdot \left(\frac{25\phi}{3} - 3\right) = \alpha - 2e_2^H - 3e_3^H + 2e_1^L\theta - \bar{c} \\ e_2^H \cdot \left(\frac{25\phi}{3} - 3\right) = \alpha - 2e_1^H + 2e_3^H - 3e_1^L\theta - \bar{c} \\ e_3^H \cdot \left(\frac{25\phi}{2} - 2\right) = \alpha - 2e_1^H + 3e_2^H + 2e_1^L\theta - \bar{c} \\ e_1^L \cdot \left(\frac{25\phi}{2\theta} - 2\theta\right) = \alpha + 3e_1^H - 2e_2^H + 2e_3^H - \bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{3(\alpha-\bar{c})\left(125\phi^3-125\phi^2+12\theta^2\right)}{3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2} \\ e_2^H &= \frac{3(\alpha-\bar{c})\left(125\phi^3-50\phi^2\theta^2-75\phi^2+12\theta^2\right)}{3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2} \\ e_3^H &= \frac{10\phi(\alpha-\bar{c})\left(25\phi^2-15\phi-6\theta^2\right)}{3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2} \\ e_1^L &= \frac{10\phi\theta(\alpha-\bar{c})\left(25\phi^2-15\phi-6\right)}{3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{250\alpha\phi^3\theta^2+375\alpha\phi^3-150\alpha\phi^2\theta^2-375\alpha\phi^2-60\alpha\phi\theta^2+36\alpha\theta^2-3125\bar{c}\phi^4+250\bar{c}\phi^3\theta^2+2375\bar{c}\phi^3+150\bar{c}\phi^2\theta^2+150\bar{c}\phi^2-180\bar{c}\phi\theta^2}{3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2} \\ c_2^H &= -\frac{625\alpha\phi^3-150\alpha\phi^2\theta^2-375\alpha\phi^2-60\alpha\phi\theta^2+36\alpha\theta^2-3125\bar{c}\phi^4+500\bar{c}\phi^3\theta^2+2125\bar{c}\phi^3+150\bar{c}\phi^2\theta^2+150\bar{c}\phi^2-180\bar{c}\phi\theta^2}{3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2} \\ c_3^H &= -\frac{250\alpha\phi^3\theta^2+625\alpha\phi^3-300\alpha\phi^2\theta^2-375\alpha\phi^2-120\alpha\phi\theta^2+36\alpha\theta^2-3125\bar{c}\phi^4+250\bar{c}\phi^3\theta^2+2125\bar{c}\phi^3+300\bar{c}\phi^2\theta^2+150\bar{c}\phi^2-120\bar{c}\phi\theta^2}{3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2} \\ c_1^L &= -\frac{250\alpha\phi^3\theta^2+625\alpha\phi^3-150\alpha\phi^2\theta^2-525\alpha\phi^2-120\alpha\phi\theta^2+36\alpha\theta^2-3125\bar{c}\phi^4+250\bar{c}\phi^3\theta^2+2125\bar{c}\phi^3+150\bar{c}\phi^2\theta^2+300\bar{c}\phi^2-120\bar{c}\phi\theta^2}{3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})\left(125\phi^3-125\phi^2+12\theta^2\right)}{3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2} \\ q_2^H &= \frac{5\phi(\alpha-\bar{c})\left(125\phi^3-50\phi^2\theta^2-75\phi^2+12\theta^2\right)}{3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2} \\ q_3^H &= \frac{25\phi^2(\alpha-\bar{c})\left(25\phi^2-15\phi-6\theta^2\right)}{3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2} \\ q_1^L &= \frac{25\phi^2(\alpha-\bar{c})\left(25\phi^2-15\phi-6\right)}{3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\cdot(25\phi-9)\left(125\phi^3-125\phi^2+12\theta^2\right)^2}{(3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2)^2} \\ \pi_2^H &= \frac{\phi(\alpha-\bar{c})^2\cdot(25\phi-9)\left(125\phi^3-50\phi^2\theta^2-75\phi^2+12\theta^2\right)^2}{(3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2)^2} \\ \pi_3^H &= \frac{25\phi^3(\alpha-\bar{c})^2\cdot(25\phi-4)\left(25\phi^2-15\phi-6\theta^2\right)^2}{(3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2)^2} \\ \pi_1^L &= \frac{25\phi^3(\alpha-\bar{c})^2\cdot\left(25\phi-4\theta^2\right)\left(25\phi^2-15\phi-6\right)^2}{(3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2)^2} \end{cases} \tag{91}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(250\phi^3-25\phi^2\theta^2-175\phi^2-15\phi\theta^2-15\phi+12\theta^2\right)}{3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2}$$

Price:

$$\frac{625\alpha\phi^4-250\alpha\phi^3\theta^2-1000\alpha\phi^3+150\alpha\phi^2\theta^2+375\alpha\phi^2+120\alpha\phi\theta^2-36\alpha\theta^2+2500\bar{c}\phi^4-250\bar{c}\phi^3\theta^2-1750\bar{c}\phi^3-150\bar{c}\phi^2\theta^2-150\bar{c}\phi^2+120\bar{c}\phi\theta^2}{3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2}$$

Firm Surplus:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(781250\phi^7-187500\phi^6\theta^2-1265625\phi^6+31250\phi^5\theta^4+93750\phi^5\theta^2+575000\phi^5-11250\phi^4\theta^4+116250\phi^4\theta^2-50625\phi^4-3750\phi^3\theta^4-105000\phi^3\theta^2+11250\phi^3+3600\phi^2\theta^4+19800\phi^2\theta^2+3600\phi\theta^4-1296\theta^4\right)}{\left(3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2\right)^2}$$

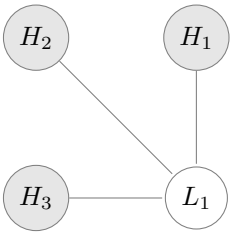
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(250\phi^3-25\phi^2\theta^2-175\phi^2-15\phi\theta^2-15\phi+12\theta^2\right)^2}{\left(3125\phi^4-500\phi^3\theta^2-2750\phi^3+225\phi^2+240\phi\theta^2-36\theta^2\right)^2}$$

Social Welfare:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^{2}\cdot\left(2343750\phi^{7}-500000\phi^{6}\theta^{2}-3453125\phi^{6}+46875\phi^{5}\theta^{4}+125000\phi^{5}\theta^{2}+1153125\phi^{5}+7500\phi^{4}\theta^{4}+416250\phi^{4}\theta^{2}+80625\phi^{4}-13125\phi^{3}\theta^{4}-198750\phi^{3}\theta^{2}+16875\phi^{3}-5400\phi^{2}\theta^{4}+10800\phi^{2}\theta^{2}+7200\phi\theta^{4}-1296\theta^{4}\right)}{\left(3125\phi^{4}-500\phi^{3}\theta^{2}-2750\phi^{3}+225\phi^{2}+240\phi\theta^{2}-36\theta^{2}\right)^{2}}$$

D.3.13 E3F [3H1L]



$$Equations: \begin{cases} e_1^H \cdot \left(\frac{25\phi}{3}-3\right) = \alpha - 2e_2^H - 2e_3^H + e_1^L\theta - \bar{c} \\ e_2^H \cdot \left(\frac{25\phi}{3}-3\right) = \alpha - 2e_1^H - 2e_3^H + e_1^L\theta - \bar{c} \\ e_3^H \cdot \left(\frac{25\phi}{3}-3\right) = \alpha - 2e_1^H - 2e_2^H + e_1^L\theta - \bar{c} \\ e_1^L \cdot \left(\frac{25\phi}{\theta}-\theta\right) = \alpha + 3e_1^H + 3e_2^H + 3e_3^H - \bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{15\phi(\alpha-\bar{c})}{125\phi^2-5\phi\theta^2+15\phi-6\theta^2} \\ e_2^H &= \frac{15\phi(\alpha-\bar{c})}{125\phi^2-5\phi\theta^2+15\phi-6\theta^2} \\ e_3^H &= \frac{15\phi(\alpha-\bar{c})}{125\phi^2-5\phi\theta^2+15\phi-6\theta^2} \\ e_1^L &= \frac{\theta(\alpha-\bar{c})(5\phi+6)}{125\phi^2-5\phi\theta^2+15\phi-6\theta^2} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{5\alpha\phi\theta^2+15\alpha\phi+6\alpha\theta^2-125\bar{c}\phi^2-30\bar{c}\phi}{125\phi^2-5\phi\theta^2+15\phi-6\theta^2} \\ c_2^H &= -\frac{5\alpha\phi\theta^2+15\alpha\phi+6\alpha\theta^2-125\bar{c}\phi^2-30\bar{c}\phi}{125\phi^2-5\phi\theta^2+15\phi-6\theta^2} \\ c_3^H &= -\frac{5\alpha\phi\theta^2+15\alpha\phi+6\alpha\theta^2-125\bar{c}\phi^2-30\bar{c}\phi}{125\phi^2-5\phi\theta^2+15\phi-6\theta^2} \\ c_1^L &= -\frac{5\alpha\phi\theta^2+45\alpha\phi+6\alpha\theta^2-125\bar{c}\phi^2-60\bar{c}\phi}{125\phi^2-5\phi\theta^2+15\phi-6\theta^2} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{25\phi^2(\alpha-\bar{c})}{125\phi^2-5\phi\theta^2+15\phi-6\theta^2} \\ q_2^H &= \frac{25\phi^2(\alpha-\bar{c})}{125\phi^2-5\phi\theta^2+15\phi-6\theta^2} \\ q_3^H &= \frac{25\phi^2(\alpha-\bar{c})}{125\phi^2-5\phi\theta^2+15\phi-6\theta^2} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})(5\phi+6)}{125\phi^2-5\phi\theta^2+15\phi-6\theta^2} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{25\phi^3(\alpha-\bar{c})^2\cdot(25\phi-9)}{(125\phi^2-5\phi\theta^2+15\phi-6\theta^2)^2} \\ \pi_2^H &= \frac{25\phi^3(\alpha-\bar{c})^2\cdot(25\phi-9)}{(125\phi^2-5\phi\theta^2+15\phi-6\theta^2)^2} \\ \pi_3^H &= \frac{25\phi^3(\alpha-\bar{c})^2\cdot(25\phi-9)}{(125\phi^2-5\phi\theta^2+15\phi-6\theta^2)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi+6)^2\cdot\left(25\phi-\theta^2\right)}{(125\phi^2-5\phi\theta^2+15\phi-6\theta^2)^2} \end{cases} \tag{92}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(10\phi+3\right)}{125\phi^2-5\phi\theta^2+15\phi-6\theta^2}$$

Price:

$$\frac{25\alpha\phi^2-5\alpha\phi\theta^2-15\alpha\phi-6\alpha\theta^2+100\bar{c}\phi^2+30\bar{c}\phi}{125\phi^2-5\phi\theta^2+15\phi-6\theta^2}$$

Firm Surplus:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(2500\phi^3-25\phi^2\theta^2+825\phi^2-60\phi\theta^2+900\phi-36\theta^2\right)}{\left(125\phi^2-5\phi\theta^2+15\phi-6\theta^2\right)^2}$$

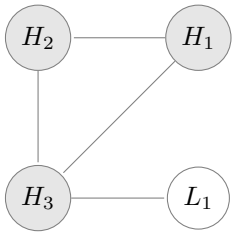
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(10\phi+3\right)^2}{\left(125\phi^2-5\phi\theta^2+15\phi-6\theta^2\right)^2}$$

Social Welfare:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(7500\phi^3-25\phi^2\theta^2+3825\phi^2-60\phi\theta^2+1350\phi-36\theta^2\right)}{\left(125\phi^2-5\phi\theta^2+15\phi-6\theta^2\right)^2}$$

D.3.14 E4A [3H1L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{2}-2\right)=\alpha+2e_2^H+e_3^H-2e_1^L\theta-\bar{c} \\ e_2^H\cdot\left(\frac{25\phi}{2}-2\right)=\alpha+2e_1^H+e_3^H-2e_1^L\theta-\bar{c} \\ e_3^H\cdot(25\phi-1)=\alpha+2e_1^H+2e_2^H+3e_1^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{3\theta}-3\theta\right)=\alpha-3e_1^H-3e_2^H+e_3^H-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{10\phi(\alpha-\bar{c})\left(5\phi-3\theta^2\right)}{625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2} \\ e_2^H &= \frac{10\phi(\alpha-\bar{c})\left(5\phi-3\theta^2\right)}{625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2} \\ e_3^H &= \frac{(\alpha-\bar{c})\left(25\phi^2-12\theta^2\right)}{625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2} \\ e_1^L &= \frac{15\phi\theta(\alpha-\bar{c})(5\phi-4)}{625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{125\alpha\phi^2-60\alpha\phi\theta^2-12\alpha\theta^2-625\bar{c}\phi^3+225\bar{c}\phi^2\theta^2+100\bar{c}\phi^2+60\bar{c}\phi\theta^2}{625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2} \\ c_2^H &= -\frac{125\alpha\phi^2-60\alpha\phi\theta^2-12\alpha\theta^2-625\bar{c}\phi^3+225\bar{c}\phi^2\theta^2+100\bar{c}\phi^2+60\bar{c}\phi\theta^2}{625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2} \\ c_3^H &= -\frac{75\alpha\phi^2\theta^2+125\alpha\phi^2-120\alpha\phi\theta^2-12\alpha\theta^2-625\bar{c}\phi^3+150\bar{c}\phi^2\theta^2+100\bar{c}\phi^2+120\bar{c}\phi\theta^2}{625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2} \\ c_1^L &= -\frac{75\alpha\phi^2\theta^2+25\alpha\phi^2-60\alpha\phi\theta^2-12\alpha\theta^2-625\bar{c}\phi^3+150\bar{c}\phi^2\theta^2+200\bar{c}\phi^2+60\bar{c}\phi\theta^2}{625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{25\phi^2(\alpha-\bar{c})\left(5\phi-3\theta^2\right)}{625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2} \\ q_2^H &= \frac{25\phi^2(\alpha-\bar{c})\left(5\phi-3\theta^2\right)}{625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2} \\ q_3^H &= \frac{5\phi(\alpha-\bar{c})\left(25\phi^2-12\theta^2\right)}{625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2} \\ q_1^L &= \frac{25\phi^2(\alpha-\bar{c})(5\phi-4)}{625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{25\phi^3(\alpha-\bar{c})^2\left(5\phi-3\theta^2\right)^2\cdot(25\phi-4)}{(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2)^2} \\ \pi_2^H &= \frac{25\phi^3(\alpha-\bar{c})^2\left(5\phi-3\theta^2\right)^2\cdot(25\phi-4)}{(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2)^2} \\ \pi_3^H &= \frac{\phi(\alpha-\bar{c})^2\cdot(25\phi-1)\left(25\phi^2-12\theta^2\right)^2}{(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2)^2} \\ \pi_1^L &= \frac{25\phi^3(\alpha-\bar{c})^2(5\phi-4)^2\cdot\left(25\phi-9\theta^2\right)}{(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2)^2} \end{cases} \tag{93}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(50\phi^2-15\phi\theta^2-10\phi-6\theta^2\right)}{625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2}$$

Price:

$$\frac{125\alpha\phi^3-75\alpha\phi^2\theta^2-125\alpha\phi^2+60\alpha\phi\theta^2+12\alpha\theta^2+500\bar{c}\phi^3-150\bar{c}\phi^2\theta^2-100\bar{c}\phi^2-60\bar{c}\phi\theta^2}{625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2}$$

Firm Surplus:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(62500\phi^5-43125\phi^4\theta^2-30625\phi^4+11250\phi^3\theta^4+10000\phi^3-1800\phi^2\theta^4-3000\phi^2\theta^2+3600\phi\theta^4-144\theta^4\right)}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2\right)^2}$$

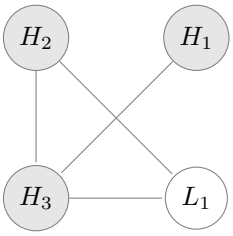
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(50\phi^2-15\phi\theta^2-10\phi-6\theta^2\right)^2}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2\right)^2}$$

Social Welfare:

$$\frac{3\phi\left(\alpha-\bar{c}\right)^2\cdot\left(62500\phi^5-39375\phi^4\theta^2-26875\phi^4+7500\phi^3\theta^4-5000\phi^3\theta^2+5000\phi^3+2400\phi^2\theta^4+1000\phi^2\theta^2+1800\phi\theta^4-48\theta^4\right)}{\left(625\phi^3-225\phi^2\theta^2-225\phi^2+12\theta^2\right)^2}$$

D.3.15 E4B [3H1L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{3}-3\right)=\alpha-3e_2^H+e_3^H-3e_1^L\theta-\bar{c} \\ e_2^H\cdot\left(\frac{25\phi}{2}-2\right)=\alpha-2e_1^H+e_3^H+2e_1^L\theta-\bar{c} \\ e_3^H\cdot(25\phi-1)=\alpha+3e_1^H+2e_2^H+2e_1^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right)=\alpha-2e_1^H+2e_2^H+e_3^H-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{15\phi(\alpha-\bar{c})\left(5\phi-2\theta^2-2\right)}{625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6} \\ e_2^H &= \frac{10\phi(\alpha-\bar{c})(5\phi-3)}{625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6} \\ e_3^H &= \frac{(\alpha-\bar{c})\left(25\phi^2-6\theta^2-6\right)}{625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6} \\ e_1^L &= \frac{10\phi\theta(\alpha-\bar{c})(5\phi-3)}{625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{100\alpha\phi^2-30\alpha\phi\theta^2-30\alpha\phi-6\alpha\theta^2-6\alpha-625\bar{c}\phi^3+100\bar{c}\phi^2\theta^2+250\bar{c}\phi^2+30\bar{c}\phi\theta^2+30\bar{c}\phi}{625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6} \\ c_2^H &= -\frac{50\alpha\phi^2\theta^2+75\alpha\phi^2-30\alpha\phi\theta^2-30\alpha\phi-6\alpha\theta^2-6\alpha-625\bar{c}\phi^3+50\bar{c}\phi^2\theta^2+275\bar{c}\phi^2+30\bar{c}\phi\theta^2+30\bar{c}\phi}{625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6} \\ c_3^H &= -\frac{50\alpha\phi^2\theta^2+150\alpha\phi^2-60\alpha\phi\theta^2-60\alpha\phi-6\alpha\theta^2-6\alpha-625\bar{c}\phi^3+50\bar{c}\phi^2\theta^2+200\bar{c}\phi^2+60\bar{c}\phi\theta^2+60\bar{c}\phi}{625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6} \\ c_1^L &= -\frac{50\alpha\phi^2\theta^2+75\alpha\phi^2-30\alpha\phi\theta^2-30\alpha\phi-6\alpha\theta^2-6\alpha-625\bar{c}\phi^3+50\bar{c}\phi^2\theta^2+275\bar{c}\phi^2+30\bar{c}\phi\theta^2+30\bar{c}\phi}{625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{25\phi^2(\alpha-\bar{c})\left(5\phi-2\theta^2-2\right)}{625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6} \\ q_2^H &= \frac{25\phi^2(\alpha-\bar{c})(5\phi-3)}{625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6} \\ q_3^H &= \frac{5\phi(\alpha-\bar{c})\left(25\phi^2-6\theta^2-6\right)}{625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6} \\ q_1^L &= \frac{25\phi^2(\alpha-\bar{c})(5\phi-3)}{625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{25\phi^3(\alpha-\bar{c})^2\cdot(25\phi-9)\left(5\phi-2\theta^2-2\right)^2}{(625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6)^2} \\ \pi_2^H &= \frac{25\phi^3(\alpha-\bar{c})^2(5\phi-3)^2\cdot(25\phi-4)}{(625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6)^2} \\ \pi_3^H &= \frac{\phi(\alpha-\bar{c})^2\cdot(25\phi-1)\left(25\phi^2-6\theta^2-6\right)^2}{(625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6)^2} \\ \pi_1^L &= \frac{25\phi^3(\alpha-\bar{c})^2(5\phi-3)^2\cdot\left(25\phi-4\theta^2\right)}{(625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6)^2} \end{cases} \tag{94}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(50\phi^2-5\phi\theta^2-20\phi-3\theta^2-3\right)}{625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6}$$

Price:

$$\frac{125\alpha\phi^3-50\alpha\phi^2\theta^2-150\alpha\phi^2+30\alpha\phi\theta^2+30\alpha\phi+6\alpha\theta^2+6\alpha+500\bar{c}\phi^3-50\bar{c}\phi^2\theta^2-200\bar{c}\phi^2-30\bar{c}\phi\theta^2-30\bar{c}\phi}{625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6}$$

Firm Surplus:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(31250\phi^5-7500\phi^4\theta^2-29375\phi^4+1250\phi^3\theta^4+2500\phi^3\theta^2+6875\phi^3-450\phi^2\theta^4-1200\phi^2\theta^2-750\phi^2+450\phi\theta^4+900\phi\theta^2+450\phi-18\theta^4-36\theta^2-18\right)}{\left(625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6\right)^2}$$

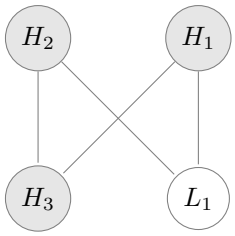
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(50\phi^2-5\phi\theta^2-20\phi-3\theta^2-3\right)^2}{\left(625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6\right)^2}$$

Social Welfare:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(93750\phi^5-20000\phi^4\theta^2-79375\phi^4+1875\phi^3\theta^4+9375\phi^3+300\phi^2\theta^4+2550\phi^2\theta^2+2250\phi^2+675\phi\theta^4+1350\phi\theta^2+675\phi-18\theta^4-36\theta^2-18\right)}{\left(625\phi^3-100\phi^2\theta^2-350\phi^2+6\theta^2+6\right)^2}$$

D.3.16 E4C [3H1L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{2}-2\right)=\alpha-3e_2^H+2e_3^H+2e_1^L\theta-\bar{c} \\ e_2^H\cdot\left(\frac{25\phi}{2}-2\right)=\alpha-3e_1^H+2e_3^H+2e_1^L\theta-\bar{c} \\ e_3^H\cdot\left(\frac{25\phi}{2}-2\right)=\alpha+2e_1^H+2e_2^H-3e_1^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right)=\alpha+2e_1^H+2e_2^H-3e_3^H-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{2(\alpha-\bar{c})(5\phi-2\theta)(5\phi+2\theta)}{625\phi^3-100\phi^2\theta^2-50\phi^2-60\phi\theta^2-40\phi+24\theta^2} \\ e_2^H &= \frac{2(\alpha-\bar{c})(5\phi-2\theta)(5\phi+2\theta)}{625\phi^3-100\phi^2\theta^2-50\phi^2-60\phi\theta^2-40\phi+24\theta^2} \\ e_3^H &= \frac{2(\alpha-\bar{c})(5\phi+2)\left(5\phi-2\theta^2\right)}{625\phi^3-100\phi^2\theta^2-50\phi^2-60\phi\theta^2-40\phi+24\theta^2} \\ e_1^L &= \frac{2\theta(\alpha-\bar{c})(5\phi-2)(5\phi+2)}{625\phi^3-100\phi^2\theta^2-50\phi^2-60\phi\theta^2-40\phi+24\theta^2} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{50\alpha\phi^2\theta^2+100\alpha\phi^2-20\alpha\phi\theta^2+20\alpha\phi-24\alpha\theta^2-625\bar{c}\phi^3+50\bar{c}\phi^2\theta^2-50\bar{c}\phi^2+80\bar{c}\phi\theta^2+20\bar{c}\phi}{625\phi^3-100\phi^2\theta^2-50\phi^2-60\phi\theta^2-40\phi+24\theta^2} \\ c_2^H &= -\frac{50\alpha\phi^2\theta^2+100\alpha\phi^2-20\alpha\phi\theta^2+20\alpha\phi-24\alpha\theta^2-625\bar{c}\phi^3+50\bar{c}\phi^2\theta^2-50\bar{c}\phi^2+80\bar{c}\phi\theta^2+20\bar{c}\phi}{625\phi^3-100\phi^2\theta^2-50\phi^2-60\phi\theta^2-40\phi+24\theta^2} \\ c_3^H &= -\frac{150\alpha\phi^2-20\alpha\phi\theta^2+20\alpha\phi-24\alpha\theta^2-625\bar{c}\phi^3+100\bar{c}\phi^2\theta^2-100\bar{c}\phi^2+80\bar{c}\phi\theta^2+20\bar{c}\phi}{625\phi^3-100\phi^2\theta^2-50\phi^2-60\phi\theta^2-40\phi+24\theta^2} \\ c_1^L &= -\frac{50\alpha\phi^2\theta^2+100\alpha\phi^2-24\alpha\theta^2-625\bar{c}\phi^3+50\bar{c}\phi^2\theta^2-50\bar{c}\phi^2+60\bar{c}\phi\theta^2+40\bar{c}\phi}{625\phi^3-100\phi^2\theta^2-50\phi^2-60\phi\theta^2-40\phi+24\theta^2} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})(5\phi-2\theta)(5\phi+2\theta)}{625\phi^3-100\phi^2\theta^2-50\phi^2-60\phi\theta^2-40\phi+24\theta^2} \\ q_2^H &= \frac{5\phi(\alpha-\bar{c})(5\phi-2\theta)(5\phi+2\theta)}{625\phi^3-100\phi^2\theta^2-50\phi^2-60\phi\theta^2-40\phi+24\theta^2} \\ q_3^H &= \frac{5\phi(\alpha-\bar{c})(5\phi+2)\left(5\phi-2\theta^2\right)}{625\phi^3-100\phi^2\theta^2-50\phi^2-60\phi\theta^2-40\phi+24\theta^2} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})(5\phi-2)(5\phi+2)}{625\phi^3-100\phi^2\theta^2-50\phi^2-60\phi\theta^2-40\phi+24\theta^2} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2(5\phi-2\theta)^2(5\phi+2\theta)^2\cdot(25\phi-4)}{(625\phi^3-100\phi^2\theta^2-50\phi^2-60\phi\theta^2-40\phi+24\theta^2)^2} \\ \pi_2^H &= \frac{\phi(\alpha-\bar{c})^2(5\phi-2\theta)^2(5\phi+2\theta)^2\cdot(25\phi-4)}{(625\phi^3-100\phi^2\theta^2-50\phi^2-60\phi\theta^2-40\phi+24\theta^2)^2} \\ \pi_3^H &= \frac{\phi(\alpha-\bar{c})^2(5\phi+2)^2\left(5\phi-2\theta^2\right)^2\cdot(25\phi-4)}{(625\phi^3-100\phi^2\theta^2-50\phi^2-60\phi\theta^2-40\phi+24\theta^2)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi-2)^2(5\phi+2)^2\cdot\left(25\phi-4\theta^2\right)}{(625\phi^3-100\phi^2\theta^2-50\phi^2-60\phi\theta^2-40\phi+24\theta^2)^2} \end{cases} \tag{95}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(50\phi^2-5\phi\theta^2+5\phi-6\theta^2-2\right)}{625\phi^3-100\phi^2\theta^2-50\phi^2-60\phi\theta^2-40\phi+24\theta^2}$$

Price:

$$\frac{125\alpha\phi^3 - 50\alpha\phi^2\theta^2 - 100\alpha\phi^2 - 20\alpha\phi + 24\alpha\theta^2 + 500\bar{c}\phi^3 - 50\bar{c}\phi^2\theta^2 + 50\bar{c}\phi^2 - 60\bar{c}\phi\theta^2 - 20\bar{c}\phi}{625\phi^3 - 100\phi^2\theta^2 - 50\phi^2 - 60\phi\theta^2 - 40\phi + 24\theta^2}$$

Firm Surplus:

$$\frac{4\phi\left(\alpha-\bar{c}\right)^2\cdot\left(15625\phi^5 - 3750\phi^4\theta^2 + 1250\phi^4 + 625\phi^3\theta^4 - 4500\phi^3\theta^2 - 1125\phi^3 + 400\phi^2\theta^4 + 500\phi^2\theta^2 - 100\phi^2 + 220\phi\theta^4 + 80\phi\theta^2 + 100\phi - 48\theta^4 - 16\theta^2\right)}{\left(625\phi^3 - 100\phi^2\theta^2 - 50\phi^2 - 60\phi\theta^2 - 40\phi + 24\theta^2\right)^2}$$

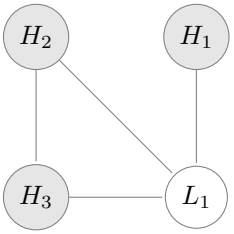
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(50\phi^2 - 5\phi\theta^2 + 5\phi - 6\theta^2 - 2\right)^2}{\left(625\phi^3 - 100\phi^2\theta^2 - 50\phi^2 - 60\phi\theta^2 - 40\phi + 24\theta^2\right)^2}$$

Social Welfare:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(93750\phi^5 - 20000\phi^4\theta^2 + 15000\phi^4 + 1875\phi^3\theta^4 - 25250\phi^3\theta^2 - 6625\phi^3 + 2300\phi^2\theta^4 - 700\phi^2 + 1340\phi\theta^4 + 760\phi\theta^2 + 300\phi - 96\theta^4 - 32\theta^2\right)}{\left(625\phi^3 - 100\phi^2\theta^2 - 50\phi^2 - 60\phi\theta^2 - 40\phi + 24\theta^2\right)^2}$$

D.3.17 E4D [3H1L]



$$Equations: \begin{cases} e_1^H \cdot \left(\frac{25\phi}{3} - 3\right) = \alpha - 3e_2^H - 3e_3^H + e_1^L\theta - \bar{c} \\ e_2^H \cdot \left(\frac{25\phi}{2} - 2\right) = \alpha - 2e_1^H + 2e_3^H + e_1^L\theta - \bar{c} \\ e_3^H \cdot \left(\frac{25\phi}{2} - 2\right) = \alpha - 2e_1^H + 2e_2^H + e_1^L\theta - \bar{c} \\ e_1^L \cdot \left(\frac{25\phi}{\theta} - \theta\right) = \alpha + 3e_1^H + 2e_2^H + 2e_3^H - \bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{15\phi(\alpha-\bar{c})(5\phi-4)}{625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2} \\ e_2^H &= \frac{10\phi(\alpha-\bar{c})(5\phi-3)}{625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2} \\ e_3^H &= \frac{10\phi(\alpha-\bar{c})(5\phi-3)}{625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2} \\ e_1^L &= \frac{\theta(\alpha-\bar{c})\left(25\phi^2-12\right)}{625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{25\alpha\phi^2\theta^2+75\alpha\phi^2-60\alpha\phi-12\alpha\theta^2-625\bar{c}\phi^3+350\bar{c}\phi^2+60\bar{c}\phi}{625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2} \\ c_2^H &= -\frac{25\alpha\phi^2\theta^2+100\alpha\phi^2-60\alpha\phi-12\alpha\theta^2-625\bar{c}\phi^3+325\bar{c}\phi^2+60\bar{c}\phi}{625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2} \\ c_3^H &= -\frac{25\alpha\phi^2\theta^2+100\alpha\phi^2-60\alpha\phi-12\alpha\theta^2-625\bar{c}\phi^3+325\bar{c}\phi^2+60\bar{c}\phi}{625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2} \\ c_1^L &= -\frac{25\alpha\phi^2\theta^2+175\alpha\phi^2-120\alpha\phi-12\alpha\theta^2-625\bar{c}\phi^3+250\bar{c}\phi^2+120\bar{c}\phi}{625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{25\phi^2(\alpha-\bar{c})(5\phi-4)}{625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2} \\ q_2^H &= \frac{25\phi^2(\alpha-\bar{c})(5\phi-3)}{625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2} \\ q_3^H &= \frac{25\phi^2(\alpha-\bar{c})(5\phi-3)}{625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})\left(25\phi^2-12\right)}{625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{25\phi^3(\alpha-\bar{c})^2(5\phi-4)^2\cdot(25\phi-9)}{(625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2)^2} \\ \pi_2^H &= \frac{25\phi^3(\alpha-\bar{c})^2(5\phi-3)^2\cdot(25\phi-4)}{(625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2)^2} \\ \pi_3^H &= \frac{25\phi^3(\alpha-\bar{c})^2(5\phi-3)^2\cdot(25\phi-4)}{(625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2\cdot\left(25\phi-\theta^2\right)\left(25\phi^2-12\right)^2}{(625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2)^2} \end{cases} \tag{96}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(50\phi^2-25\phi-6\right)}{625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2}$$

Price:

$$\frac{125\alpha\phi^3-25\alpha\phi^2\theta^2-175\alpha\phi^2+60\alpha\phi+12\alpha\theta^2+500\bar{c}\phi^3-250\bar{c}\phi^2-60\bar{c}\phi}{625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2}$$

Firm Surplus:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(62500\phi^5-625\phi^4\theta^2-73125\phi^4+21250\phi^3+600\phi^2\theta^2-5400\phi^2+3600\phi-144\theta^2\right)}{\left(625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2\right)^2}$$

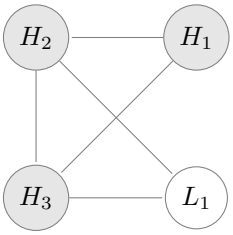
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(50\phi^2-25\phi-6\right)^2}{\left(625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2\right)^2}$$

Social Welfare:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(187500\phi^5-625\phi^4\theta^2-198125\phi^4+22500\phi^3+600\phi^2\theta^2+9600\phi^2+5400\phi-144\theta^2\right)}{\left(625\phi^3-25\phi^2\theta^2-425\phi^2+12\theta^2\right)^2}$$

D.3.18 E5A [3H1L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{2}-2\right)=\alpha+e_2^H+e_3^H-3e_1^L\theta-\bar{c} \\ e_2^H\cdot(25\phi-1)=\alpha+2e_1^H+e_3^H+2e_1^L\theta-\bar{c} \\ e_3^H\cdot(25\phi-1)=\alpha+2e_1^H+e_2^H+2e_1^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{2\theta}-2\theta\right)=\alpha-3e_1^H+e_2^H+e_3^H-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{10\phi(\alpha-\bar{c})\left(5\phi-2\theta^2\right)}{625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2} \\ e_2^H &= \frac{(\alpha-\bar{c})(5\phi-2\theta)(5\phi+2\theta)}{625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2} \\ e_3^H &= \frac{(\alpha-\bar{c})(5\phi-2\theta)(5\phi+2\theta)}{625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2} \\ e_1^L &= \frac{10\phi\theta(\alpha-\bar{c})(5\phi-2)}{625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{100\alpha\phi^2-20\alpha\phi\theta^2-8\alpha\theta^2-625\bar{c}\phi^3+100\bar{c}\phi^2\theta^2+50\bar{c}\phi^2+40\bar{c}\phi\theta^2}{625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2} \\ c_2^H &= -\frac{50\alpha\phi^2\theta^2+100\alpha\phi^2-40\alpha\phi\theta^2-8\alpha\theta^2-625\bar{c}\phi^3+50\bar{c}\phi^2\theta^2+50\bar{c}\phi^2+60\bar{c}\phi\theta^2}{625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2} \\ c_3^H &= -\frac{50\alpha\phi^2\theta^2+100\alpha\phi^2-40\alpha\phi\theta^2-8\alpha\theta^2-625\bar{c}\phi^3+50\bar{c}\phi^2\theta^2+50\bar{c}\phi^2+60\bar{c}\phi\theta^2}{625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2} \\ c_1^L &= -\frac{50\alpha\phi^2\theta^2+50\alpha\phi^2-20\alpha\phi\theta^2-8\alpha\theta^2-625\bar{c}\phi^3+50\bar{c}\phi^2\theta^2+100\bar{c}\phi^2+40\bar{c}\phi\theta^2}{625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{25\phi^2(\alpha-\bar{c})\left(5\phi-2\theta^2\right)}{625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2} \\ q_2^H &= \frac{5\phi(\alpha-\bar{c})(5\phi-2\theta)(5\phi+2\theta)}{625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2} \\ q_3^H &= \frac{5\phi(\alpha-\bar{c})(5\phi-2\theta)(5\phi+2\theta)}{625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2} \\ q_1^L &= \frac{25\phi^2(\alpha-\bar{c})(5\phi-2)}{625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{25\phi^3(\alpha-\bar{c})^2\left(5\phi-2\theta^2\right)^2\cdot(25\phi-4)}{(625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2)^2} \\ \pi_2^H &= \frac{\phi(\alpha-\bar{c})^2(5\phi-2\theta)^2(5\phi+2\theta)^2\cdot(25\phi-1)}{(625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2)^2} \\ \pi_3^H &= \frac{\phi(\alpha-\bar{c})^2(5\phi-2\theta)^2(5\phi+2\theta)^2\cdot(25\phi-1)}{(625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2)^2} \\ \pi_1^L &= \frac{25\phi^3(\alpha-\bar{c})^2(5\phi-2)^2\cdot\left(25\phi-4\theta^2\right)}{(625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2)^2} \end{cases} \tag{97}$$

Total Production:

$$\frac{10\phi\left(\alpha-\bar{c}\right)\left(50\phi^2-5\phi\theta^2-5\phi-4\theta^2\right)}{625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2}$$

Price:

$$\frac{125\alpha\phi^3-50\alpha\phi^2\theta^2-100\alpha\phi^2+20\alpha\phi\theta^2+8\alpha\theta^2+500\bar{c}\phi^3-50\bar{c}\phi^2\theta^2-50\bar{c}\phi^2-40\bar{c}\phi\theta^2}{625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2}$$

Firm Surplus:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(31250\phi^5-7500\phi^4\theta^2-8125\phi^4+1250\phi^3\theta^4-3000\phi^3\theta^2+1250\phi^3-200\phi^2\theta^4+400\phi\theta^4-16\theta^4\right)}{\left(625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2\right)^2}$$

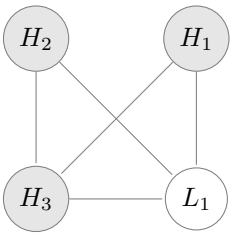
Consumer Surplus:

$$\frac{50\phi^2\left(\alpha-\bar{c}\right)^2\left(50\phi^2-5\phi\theta^2-5\phi-4\theta^2\right)^2}{\left(625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2\right)^2}$$

Social Welfare:

$$\frac{2\phi\left(\alpha-\bar{c}\right)^2\cdot\left(93750\phi^5-20000\phi^4\theta^2-20625\phi^4+1875\phi^3\theta^4-11750\phi^3\theta^2+1875\phi^3+800\phi^2\theta^4+1000\phi^2\theta^2+800\phi\theta^4-16\theta^4\right)}{\left(625\phi^3-100\phi^2\theta^2-150\phi^2-20\phi\theta^2+8\theta^2\right)^2}$$

D.3.19 E5B [3H1L]



$$Equations: \begin{cases} e_1^H\cdot\left(\frac{25\phi}{2}-2\right)=\alpha-3e_2^H+e_3^H+e_1^L\theta-\bar{c} \\ e_2^H\cdot\left(\frac{25\phi}{2}-2\right)=\alpha-3e_1^H+e_3^H+e_1^L\theta-\bar{c} \\ e_3^H\cdot(25\phi-1)=\alpha+2e_1^H+2e_2^H+e_1^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{\theta}-\theta\right)=\alpha+2e_1^H+2e_2^H+e_3^H-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{10\phi(\alpha-\bar{c})}{125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2} \\ e_2^H &= \frac{10\phi(\alpha-\bar{c})}{125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2} \\ e_3^H &= \frac{(\alpha-\bar{c})(5\phi+2)}{125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2} \\ e_1^L &= \frac{\theta(\alpha-\bar{c})(5\phi+2)}{125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{5\alpha\phi\theta^2+15\alpha\phi+2\alpha\theta^2+2\alpha-125\bar{c}\phi^2-20\bar{c}\phi}{125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2} \\ c_2^H &= -\frac{5\alpha\phi\theta^2+15\alpha\phi+2\alpha\theta^2+2\alpha-125\bar{c}\phi^2-20\bar{c}\phi}{125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2} \\ c_3^H &= -\frac{5\alpha\phi\theta^2+25\alpha\phi+2\alpha\theta^2+2\alpha-125\bar{c}\phi^2-30\bar{c}\phi}{125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2} \\ c_1^L &= -\frac{5\alpha\phi\theta^2+25\alpha\phi+2\alpha\theta^2+2\alpha-125\bar{c}\phi^2-30\bar{c}\phi}{125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{25\phi^2(\alpha-\bar{c})}{125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2} \\ q_2^H &= \frac{25\phi^2(\alpha-\bar{c})}{125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2} \\ q_3^H &= \frac{5\phi(\alpha-\bar{c})(5\phi+2)}{125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})(5\phi+2)}{125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{25\phi^3(\alpha-\bar{c})^2\cdot(25\phi-4)}{(125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2)^2} \\ \pi_2^H &= \frac{25\phi^3(\alpha-\bar{c})^2\cdot(25\phi-4)}{(125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2)^2} \\ \pi_3^H &= \frac{\phi(\alpha-\bar{c})^2(5\phi+2)^2\cdot(25\phi-1)}{(125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2(5\phi+2)^2\cdot\left(25\phi-\theta^2\right)}{(125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2)^2} \end{cases} \tag{98}$$

Total Production:

$$\frac{20\phi\left(\alpha-\bar{c}\right)\left(5\phi+1\right)}{125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2}$$

Price:

$$\frac{25\alpha\phi^2-5\alpha\phi\theta^2-15\alpha\phi-2\alpha\theta^2-2\alpha+100\bar{c}\phi^2+20\bar{c}\phi}{125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2}$$

Firm Surplus:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(2500\phi^3-25\phi^2\theta^2+775\phi^2-20\phi\theta^2+180\phi-4\theta^2-4\right)}{\left(125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2\right)^2}$$

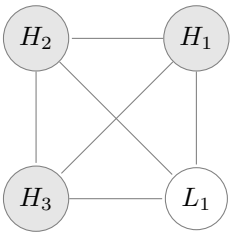
Consumer Surplus:

$$\frac{200\phi^2\left(\alpha-\bar{c}\right)^2\left(5\phi+1\right)^2}{\left(125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2\right)^2}$$

Social Welfare:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(7500\phi^3-25\phi^2\theta^2+2775\phi^2-20\phi\theta^2+380\phi-4\theta^2-4\right)}{\left(125\phi^2-5\phi\theta^2+5\phi-2\theta^2-2\right)^2}$$

D.3.20 E6A [3H1L]



$$Equations: \begin{cases} e_1^H\cdot(25\phi-1)=\alpha+e_2^H+e_3^H+e_1^L\theta-\bar{c} \\ e_2^H\cdot(25\phi-1)=\alpha+e_1^H+e_3^H+e_1^L\theta-\bar{c} \\ e_3^H\cdot(25\phi-1)=\alpha+e_1^H+e_2^H+e_1^L\theta-\bar{c} \\ e_1^L\cdot\left(\frac{25\phi}{\theta}-\theta\right)=\alpha+e_1^H+e_2^H+e_3^H-\bar{c} \end{cases}$$

Optimal efforts:

$$\begin{cases} e_1^H &= \frac{\alpha-\bar{c}}{25\phi-\theta^2-3} \\ e_2^H &= \frac{\alpha-\bar{c}}{25\phi-\theta^2-3} \\ e_3^H &= \frac{\alpha-\bar{c}}{25\phi-\theta^2-3} \\ e_1^L &= \frac{\theta(\alpha-\bar{c})}{25\phi-\theta^2-3} \end{cases}$$

Production Costs:

$$\begin{cases} c_1^H &= -\frac{\alpha\theta^2+3\alpha-25\bar{c}\phi}{25\phi-\theta^2-3} \\ c_2^H &= -\frac{\alpha\theta^2+3\alpha-25\bar{c}\phi}{25\phi-\theta^2-3} \\ c_3^H &= -\frac{\alpha\theta^2+3\alpha-25\bar{c}\phi}{25\phi-\theta^2-3} \\ c_1^L &= -\frac{\alpha\theta^2+3\alpha-25\bar{c}\phi}{25\phi-\theta^2-3} \end{cases}$$

Production Quantities:

$$\begin{cases} q_1^H &= \frac{5\phi(\alpha-\bar{c})}{25\phi-\theta^2-3} \\ q_2^H &= \frac{5\phi(\alpha-\bar{c})}{25\phi-\theta^2-3} \\ q_3^H &= \frac{5\phi(\alpha-\bar{c})}{25\phi-\theta^2-3} \\ q_1^L &= \frac{5\phi(\alpha-\bar{c})}{25\phi-\theta^2-3} \end{cases}$$

Profits:

$$\begin{cases} \pi_1^H &= \frac{\phi(\alpha-\bar{c})^2\cdot(25\phi-1)}{(25\phi-\theta^2-3)^2} \\ \pi_2^H &= \frac{\phi(\alpha-\bar{c})^2\cdot(25\phi-1)}{(25\phi-\theta^2-3)^2} \\ \pi_3^H &= \frac{\phi(\alpha-\bar{c})^2\cdot(25\phi-1)}{(25\phi-\theta^2-3)^2} \\ \pi_1^L &= \frac{\phi(\alpha-\bar{c})^2\cdot\left(25\phi-\theta^2\right)}{(25\phi-\theta^2-3)^2} \end{cases} \tag{99}$$

Total Production:

$$\frac{20\phi\left(\alpha-\bar{c}\right)}{25\phi-\theta^2-3}$$

Price:

$$\frac{5\alpha\phi-\alpha\theta^2-3\alpha+20\bar{c}\phi}{25\phi-\theta^2-3}$$

Firm Surplus:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(100\phi-\theta^2-3\right)}{\left(25\phi-\theta^2-3\right)^2}$$

Consumer Surplus:

$$\frac{200\phi^2\left(\alpha-\bar{c}\right)^2}{\left(25\phi-\theta^2-3\right)^2}$$

Social Welfare:

$$\frac{\phi\left(\alpha-\bar{c}\right)^2\cdot\left(300\phi-\theta^2-3\right)}{\left(25\phi-\theta^2-3\right)^2}$$